Research on On-Line Monitoring System of Vortex Flowmeter

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Abstract: With the rapid development of measurement technology, measurement plays an important role in economic construction, scientific research and social life. With the development of intelligent and digital technology, there are more and more intelligent flow meters based on different measurement principles. With the improvement of industrial intelligence and industrial production, the demand for centralized monitoring of flowmeter and the formation of flow monitoring system is also growing. Based on the technology of single chip microcomputer, can bus and configuration software, this paper designs a vortex flow system with open, reliable and communication functions, which improves the detection level of common vortex flow meter.

1. Introduction

Vortex flowmeter is the same as turbine flowmeter, electromagnetic flowmeter and ultrasonic flowmeter. They are all velocity flowmeter. Vortex flowmeter is a kind of cylinder which is installed in the fluid with blunt flow surface. The flow rate is obtained by detecting the frequency of regular vortex generated in the downstream of the cylinder. It has the advantages of wide range, no mechanical movable parts, small pressure loss, etc. in addition, the measurement flow is almost not affected by fluid composition, density, viscosity, pressure and other factors, and the measurement accuracy is high. It has become an indispensable member of the flow measurement instrument family, and plays an increasingly important role in the measurement and detection.

2. Characteristics and applicability of vortex flowmeter

2.1. Principle of vortex flowmeter

Vortex flowmeter is a kind of fluid oscillating flowmeter based on Carmen vortex principle. That is to say, when a non streamline symmetrical shape object vortex street flow sensor is placed in the flowing fluid, it is called vortex generator, which will produce two rows of regular vortex on both sides of its downflow, namely Carmen Vortex Street. Its vortex frequency is directly proportional to the incoming flow speed. As shown in Figure 1. The vortices are arranged asymmetrically downstream of the vortex generator.

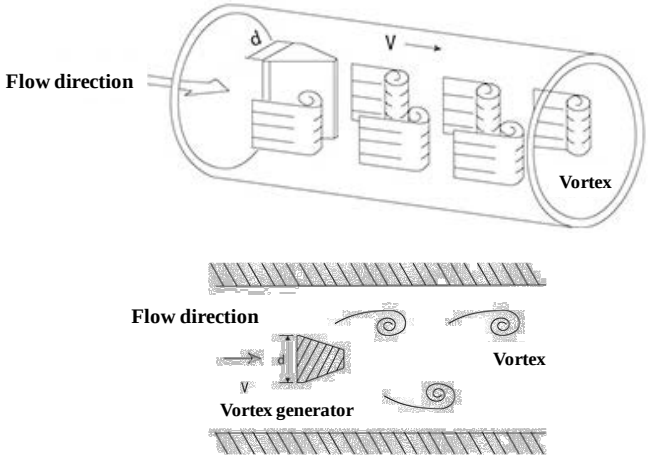

Figure1. Carmen Vortex Street

The frequency of vortex generation is directly proportional to the average flow velocity of the fluid. The velocity measured by vortex flowmeter is not the average velocity, but the velocity on both sides of vortex generator. For the turbulent state, the velocity distribution is different under different Reynolds numbers. That is to say, there are different velocity distributions under different velocity, which shows that the relationship between the velocity on both sides of the vortex generator and the average velocity of the pipeline detected by the vortex flowmeter is not unique. This shows that the nonlinear error of vortex flowmeter is determined by its detection mechanism.

2.2. Characteristics of vortex flowmeter

Because of the linear single value function relationship between vortex frequency and fluid velocity, when the Reynolds coefficient of fluid flow state is greater than the critical Reynolds coefficient, the output frequency signal is not affected by the physical density, viscosity, composition of the fluid, that is, the instrument coefficient is only related to the shape of vortex generator. However, the geometry size of vortex generator is constant, which makes vortex flowmeter can be widely used in the measurement of different fluid flow, and the measurement accuracy is constant when the instrument constant is constant.

Vortex flowmeter is not suitable for measuring low Reynolds coefficient fluid. When the Reynolds coefficient is low, the Strophe number will change with the Reynolds coefficient, the linearity of the instrument will change, and the viscosity of the fluid will be high, which will significantly affect or even hinder the generation of the vortex. One of the limiting conditions for selection is that it cannot be used under the boundary Reynolds coefficient.

3. Design of on-line monitoring system for vortex flowmeter

3.1. Overall design of flow monitoring system

The network topology adopts the bus structure. Although this structure has lower information throughput than the ring structure, it is simple in structure, low in cost, and uses passive tap connection, so the system has high reliability. Can bus connects each network node to form a multi node network, and the transmission medium is twisted pair. Because the system is applied in the industrial field, in order to improve the anti-interference ability of the system step by step, a high-speed optocoupler is added between the controller and the transmission medium for photoelectric isolation, and the flow nodes are powered by batteries, with power-off protection and other measures.

The design of signal processing circuit is the process of all kinds of interfaces and functional modules which are needed by DSP as the core external program. The key point of design is to ensure that all parts play their functions and run coordinately. The specific connection circuit diagram of power supply is shown in Figure 2.

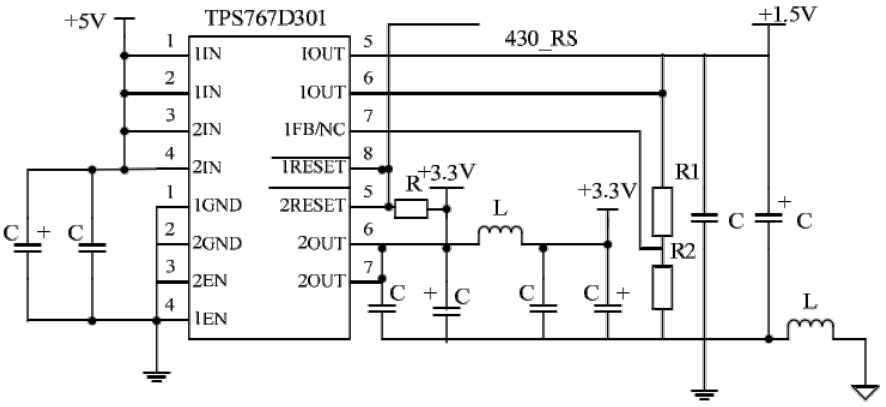

Figure2. Power supply circuit

3.2. Design of vortex flow sensor

Piezoelectric crystal has the characteristics of fast response, strong signal, good technology and

low manufacturing cost. The vortex flowmeter made of piezoelectric crystal has the characteristics of wide working temperature range, strong field adaptability and high reliability. Piezoelectric stress vortex flowmeter has been paid more and more attention in the industry of our country, and now it has become the mainstream product of vortex flowmeter. In the symmetrical flow sensor designed in this paper, piezoelectric crystal is used.

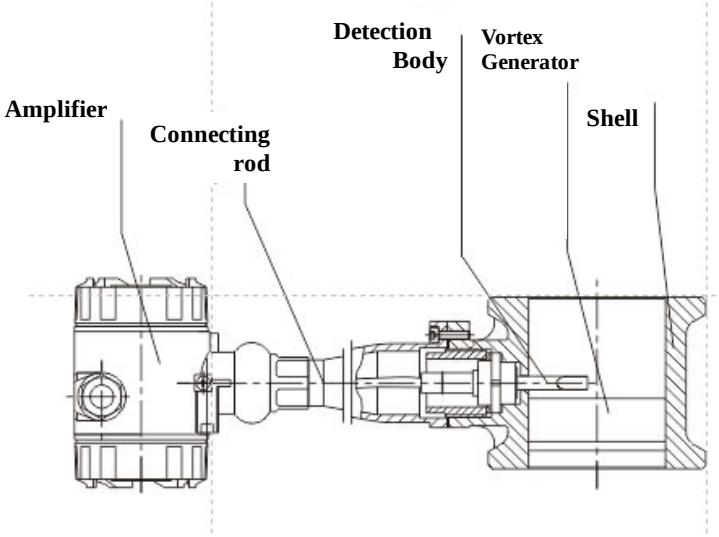

Figure3. Structure of vortex flow sensor

As shown in Figure 3, the relationship between the release frequency f of the vortex and the flow velocity V of the fluid and the width D of the upstream surface of the vortex generator in a certain range of Reynolds number ($2\times104\text{-}7\times10^6$) can be expressed by the following formula: F = SR×V / D, in which f is Carmen Vortex Street's release frequency; Sr coefficient (called Strouhal number), v-velocity, d-width of the triangular cylinder. Strouhal number is an important coefficient of vortex flowmeter. In the straight part of the curve with SR ≈ 0.16, as long as the frequency f is accurately measured, the fluid velocity v = f×D/SR can be measured, so as to achieve the purpose of measuring the fluid flow in the pipeline.

3.3. Software design of vortex flowmeter

Kingview is a general-purpose configuration software with ease of use, openness and integration capabilities. The application of Kingview can make engineers focus on the control objects, rather than on the complex graphics processing and boring statistics. In order to facilitate the use of users, the interface is divided into two categories: main screen and site screen. The interface is generally two to three layers. This design not only takes into account the ease of use of the software, but also better classifies the software functions. Different networking modes can be selected in the main interface. The main interface provides communication mode selection, current traffic display, current date and user login functions. The site interface provides data display, pipeline selection, database display, printing and curve drawing functions.

4. Conclusions

The on-line detection system of vortex flowmeter designed in this paper integrates the technology of single chip microcomputer, field bus, configuration software, etc. based on CAN bus, it is a vortex flowmeter integrating vortex flowmeter sensor, converter and intelligent integrator. The vortex flowmeter has the advantages of high measurement accuracy, good linearity, wide measurement range, strong anti-vibration ability and good reliability. It has made a great stride in the direction of intelligence. It integrates detection, calculation, display and communication, becomes a node of fieldbus, and realizes two networking modes.

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