International Journal of Engineering Applied Sciences and Technology, 2021
Vol. 5, Issue 11, ISSN No. 2455-2143, Pages 120-123
Published Online March 2021 in IJEAST (http://www.ijeast.com)

A NEW ELECTROMAGNETIC FLOWMETER BASED ON EXCITATION SELF-ADAPTATION TECHNOLOGY

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***Abstract*— a new self-adaptive electromagnetic flowmeter and measurement method, including fluid property sensor group, signal processing circuit, microprocessor, D/A excitation signal generator, data processing module, LCD display. The fluid property sensor group detects the fluid related information and outputs the electrical signal to the signal processing circuit. After filtering and amplifying, the undistorted signal is obtained and connected to the microprocessor. After analysis, the fluid information is provided. According to the transmitted fluid information, the measurement method is determined: when the conventional fluid is used, the phase is called a variety of excitation signals are generated by the microprocessor and processed as A/D frequency matching signals of the excitation generator connected with LCD for display, the measurement accuracy of electromagnetic flowmeter is improved, and the accurate measurement is realized.**

Keywords— **Electromagnetic flowmeter; Signal processing; Flow measurement, Self-adaptation**

I. INTRODUCTION

One of the purposes of using the flowmeter is to provide the manager or the control system with the accurate value of the flow parameters in the production process, so as to make reasonable judgment and adjustment, achieve excellent control, and improve the quality and output of products. Electromagnetic flowmeter is an instrument to measure the volume flow of conductive liquid according to Faraday's law of electromagnetic induction[1]. Its excitation technology determines the characteristics of the magnetic field of the electromagnetic flow sensor, so the advanced excitation technology affects the detection accuracy of the electromagnetic flowmeter. With the development of electromagnetic flowmeter, excitation technology has gone through five stages: DC excitation, power frequency sine wave excitation, low frequency rectangular wave excitation, low frequency ternary rectangular wave excitation and dual frequency rectangular wave excitation. However, these excitation technologies have their own shortcomings, such as the polarization effect of electrode caused by DC excitation, the influence of orthogonal interference caused by power frequency sine wave excitation and so on. Even the differential interference and in-phase interference introduced by the most commonly used low-frequency rectangular wave excitation technology make the

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sensor output signal inductive signal-to-noise ratio significantly reduced at the stage of small flow rate, resulting in great measurement error. In modern industry, flow measurement is an essential link in industrial production, and flow is also one of the five measurement parameters. Accurate measurement is very helpful for production guidance and planning. At present, most of the flowmeters in our country are ordinary flowmeters, and most of them are rectangular wave excitation technology. At present, the existing excitation methods have gradually solved the problems of low measurement accuracy, poor zero stability, large differential interference and co direction interference, but a single excitation method is still difficult to meet the requirements of different fluid velocity measurement. For example, in the electromagnetic flowmeter excited by ternary low-frequency rectangular wave, when measuring mud, pulp and other solid particles and low conductivity fluid, electrical noise will be generated, which makes the output signal extremely unstable. If double frequency rectangular wave excitation is used, this problem can be effectively solved [2].

II. THE ESTABLISHEMENT OF THE MODEL WITH SINGLE HOLE

An adaptive new electromagnetic flowmeter and its measuring method include a fluid property sensor group, a signal processing circuit, a microprocessor, a D/A excitation signal generator, a frequency sweeping circuit, a data processing module[3] and an LCD display screen. It is characterized in that the fluid property sensor group is connected with the signal processing circuit, and the signal processing circuit selects the odd harmonic amplitude which is least disturbed by the fluid noise to reflect the size of the flow signal according to the frequency spectrum characteristics of the output signal of the fluid property sensor group, so as to reduce the noise interference[4], so that the measuring device can correctly extract the flow information from the output signal. Then the basic information of the detected fluid is analyzed and compared with the fluid parameters set by the measuring device to get the fluid address code needed by the measuring device. The microprocessor receives the address code transmitted by the signal processing circuit to select the excitation mode, and calls the selected excitation mode generation program and D/A excitation mode[5]. The combination of the generator circuit and the fluid is the most suitable excitation mode. However, when the measured fluid is very special and many conventional excitation modes designed in the measuring device cannot match, the measuring device will automatically measure by frequency sweep[6]. The microprocessor provides the sweep signal for the sweep circuit. The sweep signal generated by the microprocessor is added to the D / a excitation signal generator, and the voltage signals at different frequencies are obtained by measuring the excitation waves of different frequencies[7]. The voltage signal under the excitation frequency is analyzed and compared, and the excitation frequency corresponding to the highest signal-to-noise ratio, the smallest waveform changes with time, that is, the best stability and the most concentrated power spectrum, is selected as the excitation mode of the special fluid. Finally, the data processing module is used[8]. The excitation unit of the electromagnetic flowmeter is excited and sampled to obtain the analog signal of excitation current and voltage, and the corresponding digital signal is obtained after analog-to-digital conversion. The fluid flow rate in the sampling period is calculated from the excitation current and voltage of the digital signal in the same sampling period after conversion, and the optimal result is reflected on the LCD display[9].

The fluid property sensor group is composed of a fluid conductivity sensor, a fluid particle content sensor and a fluid viscosity sensor, which is mainly used for detecting the fluid properties in the pipeline, including fluid conductivity, solid particle content and fluid viscosity. In order to accurately output the relevant information of the detected fluid through the fluid property sensor group, the new electromagnetic flowmeter can accurately detect the fluid information when different flow indicators flow through the pipeline[10]. The signal processing circuit is composed of a high pass filter circuit, a low pass filter circuit and an amplifying circuit, which is used to filter out small DC components and high-frequency peak interference in the signal[11]. Finally, the amplifying circuit amplifies the signal after the filter circuit, so as to achieve the purpose of signal fidelity and facilitate analysis and processing. Further judge whether the type of detected fluid matches the address code set by the measuring device[12].

When there is fluid passing through the pipeline, the fluid property is detected by the fluid property sensor group, and the odd harmonic amplitude of the output signal detected by the sensor is selected to reflect the size of the flow signal, so as to avoid the noise interference, so that the measurement device can correctly extract the flow information from the output signal. Then, the basic information of the detected fluid is analyzed, and compared with the fluid parameters designed by the measuring device, the fluid address code needed by the measuring device is obtained. According to the address code obtained from the detection results, whether the existing excitation mode can meet the measurement requirements is judged. If it can, the microprocessor will control and select the matching excitation mode program, and the corresponding waveform will be generated by the D / A excitation signal generator and loaded into the excitation coil to measure the fluid flow rate; if not, the measured fluid is very special, and the existing excitation mode cannot achieve the purpose of accurate measurement of flow rate. The microprocessor generates the sweep signal and scans the ternary rectangular wave through the sweep circuit to obtain multiple groups of data. After the data comparison and analysis, the excitation frequency corresponding to the best data is taken as the excitation mode of the special fluid to measure the flow rate.

III. THE INFLUENCE OF LEAKAGE PORE DIAMETER ON THE FLOW FIELD

The experimental platform is composed of water pump, pipeline, water tank, manual valve, electromagnetic flowmeter, signal conditioning circuit and signal acquisition system. The circulation system is composed of water pump, valve, standard flowmeter and electromagnetic flowmeter. The accuracy of trapezoidal wave excitation electromagnetic flowmeter can be calibrated by adjusting the standard flowmeter. The flow in pipeline can be controlled by the opening of flow control valve. System, signal processing circuit through filtering, noise reduction, amplification and other functions of signal distortion processing, so that the signal to the sensor is optimized, and finally realize the flow signal display, and complete the data processing.

Fig. 8 system field test [4]

The collected 26 data are respectively inserted into the excel table in the form of line graph, and the flow voltage function diagram is drawn. The induced electromotive force signals corresponding to the steady state of four excitation signals are selected, and the voltage value is calculated by zero compensation method. Under the same flow rate, the induced voltage is measured for many times for averaging, and the relationship between the induced voltage value and the flow rate is obtained, as shown in Table 1 below

Table 9 relationship between voltage and flow rate

Standard meter flow rate (m3 / h)	Voltage value (V)
0. 000	0. 002
5. 377	0. 026
10. 879	0. 085
16. 173	0. 080
23. 650	0. 130
30. 576	0. 184
37. 324	0. 210
44. 061	0. 236
50. 094	0. 261
56. 842	0. 299
63. 510	0. 340
69. 506	0. 390
76. 079	0. 407

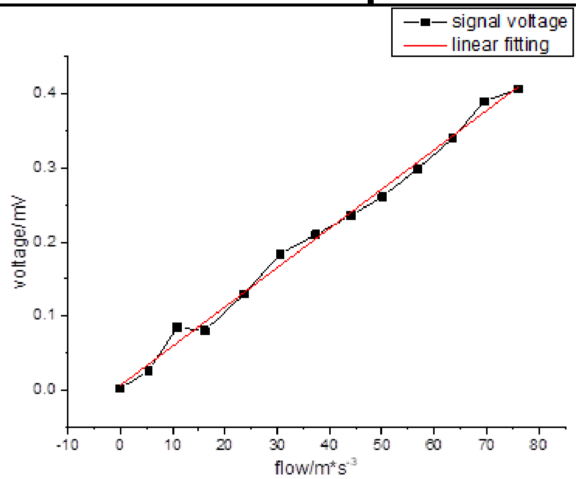

Fig. 9 Relationship between voltage and flowrate

According to the figure above, the fitting function is expressed by y=0. 00531x+0. 00627. The degree of freedom is 11, and the R2 is 0. 99282. Therefore, the linearity is very good for this proposed self-adaptive electromagnetic flowmeter.

IV. CONCLUSION

An adaptive new electromagnetic flowmeter and its measurement method include a fluid property sensor group, a signal processing circuit, a microprocessor, a D / a excitation signal generator, a data processing module and an LCD display screen. The fluid property sensor group detects the fluid related information and outputs the electrical signal to the signal processing circuit. After filtering and amplifying, the undistorted signal is obtained and connected to the microprocessor. After analysis, the fluid information is provided. According to the transmitted fluid information, the measurement method is determined: when the conventional fluid is used, the phase is called. When the fluid is unconventional, the microprocessor sends out a variety of set frequencies as sweep signals, which are added to the D / a excitation signal generator. The D / a excitation signal generator generates different shapes of excitation waves or excitation waves of a variety of frequencies. The microprocessor analyzes the signals from the signal processing circuit and connects them to the D / a excitation signal generator connected with LCD for display, the measurement accuracy of electromagnetic flowmeter is improved, and the accurate measurement is realized.

V. ACKNOWLEDGMENT

This work is supported by National College Students' innovation and Entrepreneurship Project (No. 201910615033), and the Key Open Experiment Project of Southwest Petroleum University.

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