METHOD OF DETERMINING THE MASS OF LIQUID GAS IN THE CLOSED RESERVOIR AND ITS REALIZATION

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Summary

The system of measuring the mass of liquid gas and the algorithm of its performance is discussed in the article. The system enables to measure the mass of liquid gassed by means of electromagnetic waves raised by the resonator put in a reservoir. The system has high precision of measuring and it is distinguished with its simple construction. The high precision of measuring is provided by the type of a resonator and the microprocessor in which three own frequencies of a resonator are shown and the algorithm of measuring the mass of liquid gas is realized.

Keywords: Measuring device, Liquefied gas, resonance frequency

1. Introduction

There exist various methods of measuring the mass of gas that are actively applied in practice today. We aim at working out such a system that shall be more accurate compared with the existing one and herewith the constructive decision will be easier.

It must be noted that there exists the liquid level determinative mass measuring instrument with three sensitive elements given in the form of a coaxial tube. The exit signal through the tube does not depend on dielectrical permeability of control liquid. By means of the mentioned equipment only the size can be determined, while it is almost impossible to measure the mass of liquid in closed reservoir; besides the existence of the three sensitive elements complicate the construction of the equipment. Another measuring system, known to us, has three sensitive elements presented with three coaxial tubes of various lengths. In the process of measuring the shortest tube is in the gaseous state, the length of the second one is equal to alternation range of liquid gas level and the third one is of shortened size. The mass measuring depends on the significance of electromagnetic waves raised on each element. The simple algorithm of mass measuring if realized by means of the mentioned equipment, though its three elements increases the size ratio of measuring system and herewith requires a very high precision of informational determination. It is important to simplify the existing measuring system and increase the measuring precision, as well as minimize possibility of errors.

2. The main part

Electromagnetic method of control and measuring is applied in the system provided by us, which is used for measuring the mass of liquid gas, including any one-phase (gas or liquid) or two-phase (gas or liquid) phasic state liquids.

The provided instrument is used for measuring the mass of liquid gas, as well as cryogenic liquids (nitrogen, helium) in closed reservoir despite their phasic state: one-phase (gas or liquid) or two-phase (gas or liquid, which are divided by an abrupt bounder between them). This instrument may be used for measuring the two environment dividing boundary levels ("gas-liquid").

The alternation algorithms of resonance frequencies as well as their transformation for measuring the mass of liquid gas are realized in the micro processing block of the given instrument.

According to the significance of dividing $_X$ boundaries (level) and their dielectrical permeability between phases we shall get various functional attitudes of resonance frequencies f_i (i = 1,2,3) in the process of successive replenishment of sensitive part of the excited resonator with liquid gas in two-phase condition, at the initial three own frequency.

This kind of relation depends only on the state of two environment dividing boundary and not on dielectrical permeability of gaseous and liquid phases of controlling environment.

$$\psi(x) = \frac{\frac{f_{01}^2 - f_{02}^2}{f_1^2 - f_2^2}}{\frac{f_{02}^2 - f_{03}^2}{f_2^2 - f_3^2}} \quad (1)$$

where f_{oi} are frequencies of complete immersion of the resonator sensitive part in gaseous phase.

When there exists certain correlation between the length of cables and lines with clearance function becomes rectilinear.

For instance, in cylindrical reservoir, the height of which is *H,* the mass of liquid gas id measured by the following formulae:

$$M = K\left(\frac{E_g - 1}{E_g + 2}\frac{x}{H} + \frac{E_l - 1}{E_l + 2}\left(1 - \frac{x}{H}\right)\right) \quad (2)$$

where *K* is a permanent quantity of the known substance.

According to the (1) formulae we get $\psi(x)$ and the condition of two phase dividing boundary of liquid gas $x=x^*$ is calculated as the opposite size of $\psi(x)$.

By inserting $x=x^*$, $E_g=E_g^*$, $E_l=E_l^*$ in (2) formulae we shall get the current condition of liquid gas mass which is given in the 16th block of indication.

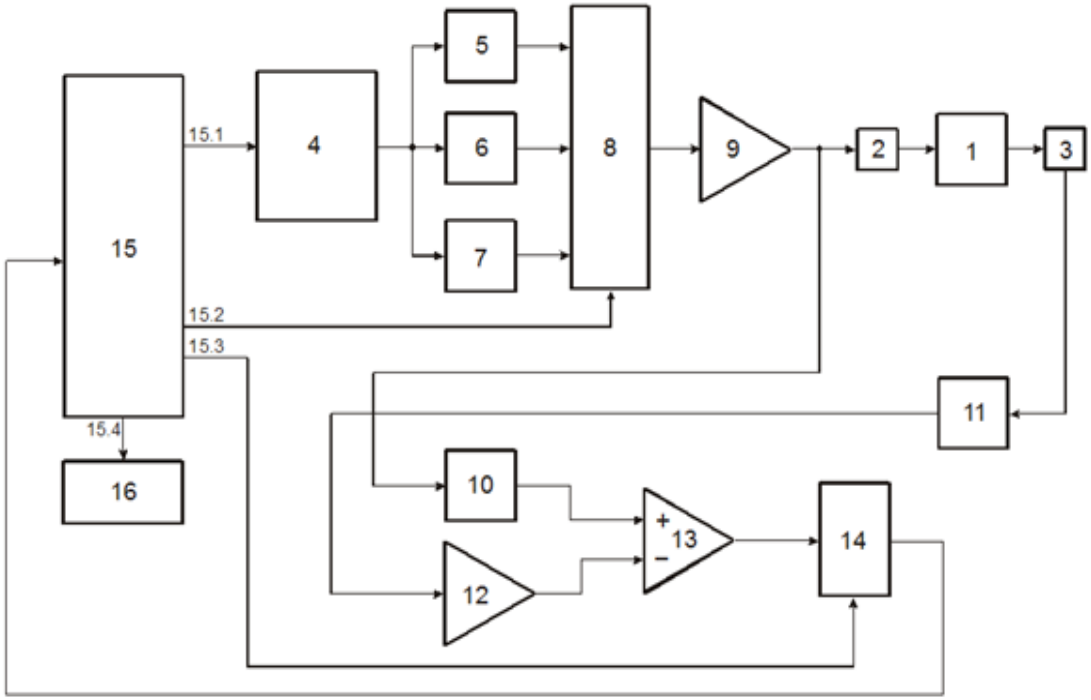

Fig.1. 1 – Electromagnetic resonator, which is a sensitive element;

2, 3 – Two elements connecting the resonator; 4 – Synthesis circuit; 5,6,7 – Filter;
8 – Selector; 9 – Wide stripe amplifier; 10,11 – Detector; 12 – Amplifier;
13 – Differential Amplifier; 14 – Analogical-digital transformer;
15 – Microprocessor block; 15_1, 15^2, 15^3 – Exits of microprocessor blocks.

The instrument for measuring the mass of liquid gas in closed reservoirs is composed with electromagnetic resonator built-in the reservoir and electronic transformer of frequency transforming electromagnetic wave generator. The mentioned equipment is exceptional because of the electromagnetic resonator which is made of metal tube in the wall of which along the tube there is a stretched meander-form hole type uninterrupted line.

The end of the hole-type line reaches one of the walls of the tube and is connected to the appropriate cable with short circuit end by means of which it is connected to the wide belt amplifier through the first element of the connection, the entrance of which is connected to the exit of the selector.

Each of the three entrances of the selector is connected to the digital exit of the micro processor block with appropriate filter through the frequency synthesis circuit. The same cable is connected to the entrance of the first amplitude detector with the short circuit end through the first element of the connection the exit of which is connected to one of the exits of the differential amplifier. The second cable is connected to the second amplitude detector through the second element of the connection.

The amplifier is connected to the second entrance of the differential amplifier the exit of which is connected to the entrance of the analogical-digital transformer and the digital exits are connected to the digital entrances of micro processor block, the first exit of which is connected to the synthesis circuit, the second – the control entrance of the selector, the third – to the entrance of analogical-digital transformer starting unit and the forth exit is connected to the indication block.

In the block "Synthesis circuit-Filter-Selector" electromagnetic waves of the three own frequency alternation range of the resonator is consecutively formed.

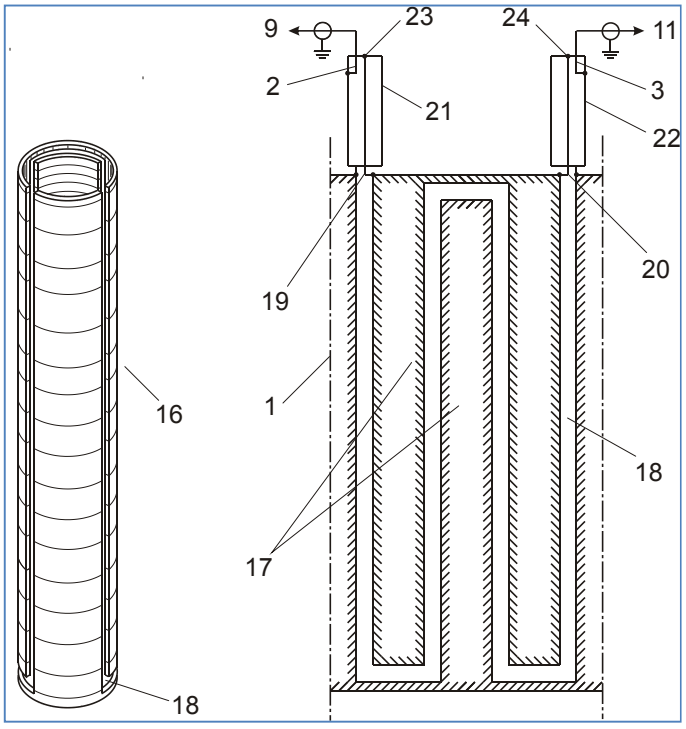

Fig.22. 1-Resonator; 2,3 - Two elements connecting the resonator; 9 – Wide stripe amplifier; 11 – Detector; 16 – sensitive part; 17 - metal pipe; 18 - Slit line; 19, 20, 23, 24 - The ends of the slotline; 21, 22 - cable

3. Conclusion

The type of the resonator provides the system simplification and increase of measuring precision, which is presented by means of uninterrupted hole-type line in the wall of metal tube and in which each end of the line is connected to the short circuit end of the coaxial cable.

The achievement of the goal shall be provided by the frequency synthesis circuit the exit of which is connected to the selector controlled by the signal received from the micro- processor through appropriate filter.

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МЕТОД ОПРЕДЕЛЕНИЯ МАССЫ ЖИДКОГО ГАЗА В ЗАКРЫТОМ РЕЗЕРВУАРЕ И ЕГО РЕАЛИЗАЦИЯ

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Резюме

Рассмотрена система измерения массы жидкого газа и алгоритм ее работы. С использованием этой системы возможно измерение массы жидких газов по электромагнитным колебаниям, возбужденным в резонаторе, опущенном в резервуар. Система обладает высокой точностью измерений и отличается простой конструкцией. Достижение высокой точности измерений обеспечивается типом резонатора и микропроцессором, в котором фиксируются три собственные частоты резонатора и реализуется алгоритм определения массы жидкого газа.

ჩაკეტილ რეზერვუარში თხევადი აირის მასის განსაზღვრის მეთოდი და მისი რეალიზაცია

ზაალ აზმაიფარაშვილი, ნინო ოთხოზორია, მედეა ნარჩემაშვილი

საქართველოს ტექნიკური უნივერსიტეტი

რეზიუმე

სტატიაში განხილულია თხევადი აირის მასის გაზომვის მოწყობილობა და მისი მუშაობის ალგორითმი. სისტემის გამოყენებით შესაძლებელია რეზერვუარში ჩაშვებულ რეზონატორში აღძრული ელექტრომაგნიტური რხევებით თხევადი აირების მასის გაზომვა. სისტემას გააჩნია გაზომვის მაღალი სიზუსტე და გამოირჩევა მარტივი კონსტრუქციით. გაზომვის მაღალი სიზუსტის მიღწევას უზრუნველყოფს რეზონატორის ტიპი და მიკროპროცესორი, რომელშიც რეზონატორის სამი საკუთარი სიხშირე ფიქსირდება და ხდება თხევადი აირის მასის განსაზღვრის ალგორითმის რეალიზაცია.