Analysis of modern requirements for flowmeters and hot-meter water development
Tashmatov Kh.[1], Muzafarov A.[2] (Republic of Uzbekistan)

Анализ современных требований к расходомерам и разработка термоанемометрического расходомера воды
Ташматов Х. К.[1], Музафаров А. Р. (Республика Узбекистан)

Ташматов Хайит Каршиевич / Tashmatov Khayit - кандидат технических наук, доцент;
Музафаров Анвар Рустамович / Muzafarov Anvar - студент 2 курса,
энергетический факультет, кафедра гидроэнергетики,
Ташкентский государственный технический университет, г. Ташкент, Республика Узбекистан

Abstract: *this article discusses basic requirements for modern fluid flow meters, and on the basis of the analysis developed by the new Hot-water meter. We give the main technical characteristics of the developed liquid hot-wire flowmeter.*

Аннотация: *в данной статье рассматриваются основные современные требования к расходомерам жидкости и на основе анализа разработан новый термоанемометрический расходомер воды. Дается основные технические характеристики разработанного термоанемометрического расходомера жидкости.*

Key words*: consumption, accuracy, reliability, speed, measuring range, accuracy, thermoanemometric flowmeter.*

Ключевые слова*: расход, точность измерения, надежность, быстродействие, диапазон измерения, погрешность, термоанемометрический расходомер.*

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The value of the fluid flow, gas and steam in the modern industrial society is extremely high. Their role is increased by the need to maximize savings of energy and water resources of the country are becoming more and more expensive.

Without flow control cannot be achieved, and especially optimization of technological regimes in the energy sector, metallurgy, oil, gas, pulp - paper, food and many other industries. Without these devices possible and automation of production, and maximize its efficiency.

Modern requirements for flowmeters are many and varied. Satisfy all requirements together is very difficult, if not impossible. Some types of devices to a greater extent satisfy the requirements of one and the other - the other.

1. High accuracy. This is an important requirement. Previously, the measurement error of 1.5-2% was considered acceptable, it is now often required to have an error of not more than 0.2-0.5%. This very small error already achieved in chamber counters and liquids (blade, roller-blade) and a number of other counters.

2. High reliability. This is the second most important requirement. It is estimated the time during which the device remains in operation and achieved accuracy. This time depends on the type of instrument and on the conditions of its application. Some flowmeters and their components that do not have moving parts, can work reliably for a long time**.**

3. Minor dependence of the accuracy of measurement of density variations. Only the heat flow [1] measuring mass flow, have this valuable property. Other types of devices need to have the device automatically introducing a correction in the density change, or at least the temperature and pressure of the medium.

4. Performance of the device or a high dynamic performance. This requirement is important when the flowmeter is used in automatic control systems and in measuring rapidly varying costs. Performance is convenient to estimate the value of the time constant *T* of the device, i.e., the time during which the indication at its abrupt change of flow q_1 to q_2 are changed by approximately two-thirds of the value (q_2 - q_1). There is a very large scale performance of *T*, measured in hundredths (even less) of a second from the turbine, to *T*, measured in tens of seconds of thermal flowmeters.

5. Large range of variation (q_{max} / q_{min}). In devices with linear characteristic, he is 8-20 or more, and at a flow orifice (SU) having a quadratic-characterized tics, it is only 3-10. If necessary, it can be increased to 16 by connecting SU two differential pressure with different Δp_{max}.

6. Provision of metallurgical base. Exemplary flow metering installation to calibration and calibration of different flow meters, complicated and expensive, especially for large expenditures verified. Mere flowmeters do not require SU exemplary flow units because for the majority of species have been experimentally established and normalized their coefficients costs and expanded in the international standard ISO 5167 and other ISO recommendations.

7. Very large flow range to be measured. To measure the liquid should cost in the range of 10^{-2} to 10^{7}-10^{8} kg/h and gases - in the range of 10^{-4} to 10^{5}-10^{6} kg / hr, i.e. costs differ by ten orders of magnitude. Particular

difficulties arise when measuring very small and very large costs. It is often necessary to use special methods of measurement, such as the partial (at great expense).

8. The flow measurement is necessary not only in conventional but also in experimental conditions, with very low or very high temperature and pressure. Thus, the consumption of cryogenic liquids, such as liquefied hydrogen, it is necessary to measure at very low temperatures (up to -255^{0}C), and the flow of superheated steam ultra-high pressure and flow rate of molten metal coolant - at temperatures up to + 600^{0}C.

Such conditions pose additional challenges to ensure a reliable flow measurement.

9. Wide range of measured substances. The substances may be not only single-phase and single-component, but also multiphase and multi-component. Thus it is necessary to consider both the specific properties of the substance (aggressiveness, abrasiveness, toxicity, explosiveness, etc.) and its parameters (pressure, temperature). Meanwhile, the main flow measuring methods have been developed for single phase fluids (liquid, gas and steam). Now all the more urgent becomes the problem of measuring two-phase and three-phase sometimes even substances.

On the basis of modern requirements of existing flow meters, at the department of "Hydropower and hydraulics" Energy faculty of Tashkent State Technical University authors designed Hot-water flowmeter in pipeline construction.

Figure 1 shows a diagram of the structure of the thermal hot-wire transducer type that was used in the control of water flow in pumping stations and open channels [2].

The design of the heat flow meter is a hot-wire type tube portion 6 which consecutively installed protective casing 4 and 5, which are placed in thermo sensitive element (TSE) 2 and 3, wherein TCHE 3 is provided with a heating element 1. As used TSE 2 and3 semiconductor thermistor, are included in the shoulder bridge measurement circuit shown in Fig. 7. Shoulder bridge circuit 7 and 8 are fixed resistors. The resistance 10 is connected parallel to the compensation TCHE 3 and serves to adjust the temperature compensation string in the bridge circuit. 9 variable resistor is used to adjust the output voltage applied to the digital voltmeter 11. Power bridge circuit and the circuit of the heating element 1 was carried out by the power supply unit 12.

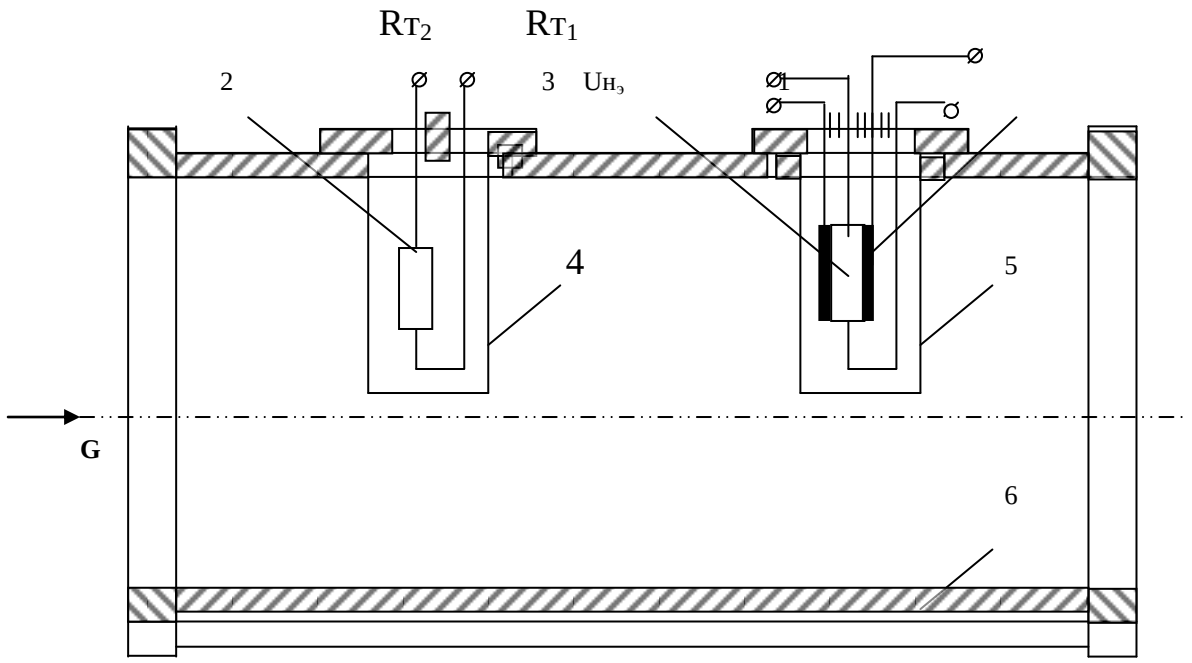

Fig. 1. The construction of the thermal converter type hot-wire flow rates.

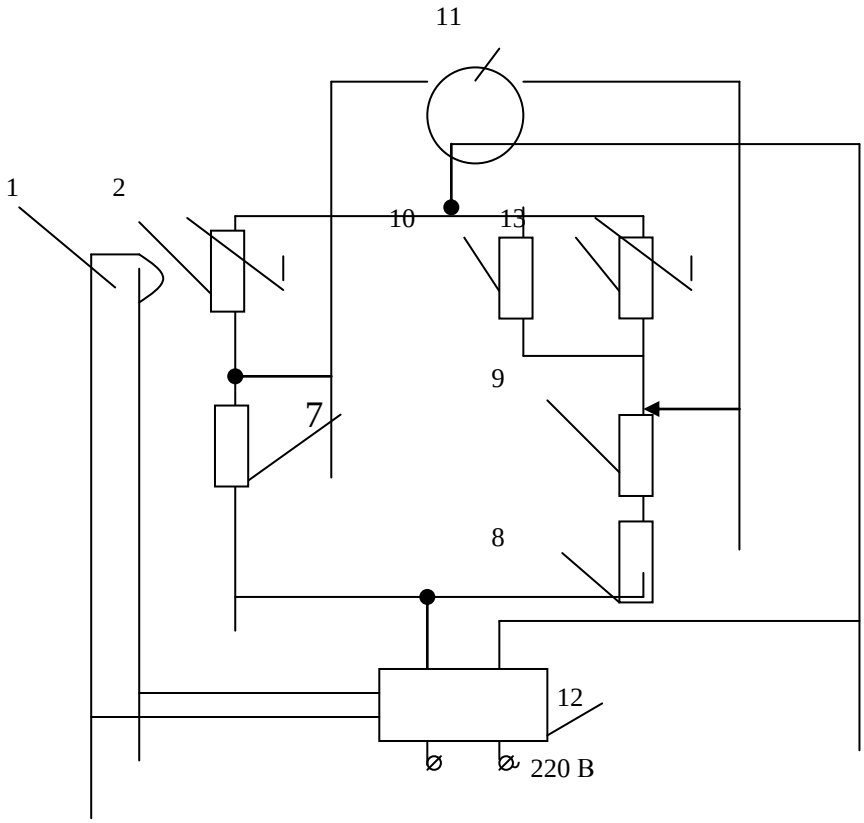

Fig. 2. The measuring circuit of thermal hot-wire type flowmeter

Designed thermal hot-wire type flow meter is used to control water flow at a rate of 0 - 3 m / s with an error of no more than 2.0%.

Importantly, the hot-wire transmitters have a number of advantages that are not implemented in conventional papers. Hot-wire transducers are essentially probe transducers. The thermal flowmeter design thermoanemometric converter heater 1 and the primary temperature sensor 3 (Fig. 2) located in the stream and by removing them from the wall of the tube 4, the whole thermal capacity heater 1 is involved in heat exchange with the flow, and there is no parasitic heat losses that ultimately provides the hot-wire converter high accuracy. In addition, among the calorimetric converters and inverters boundary layer hot-wire transducers have a higher speed and sensitivity. Several studies have shown [3, 4], which is based on hot-wire converters can develop multifunctional thermal flowmeters flow parameters (velocity, flow quantity, the temperature, the presence and direction of flow). In the development of multi-functional heat flow is necessary to combine thermal converters with microprocessor sets. These tasks can be easily implemented on the basis of hot-wire transducers.

The foregoing shows that the creation of multi-function thermal converters flow of gases and liquids are the most promising thermal hot-wire type converters in conjunction with microprocessor sets. However, ready-made design of multifunctional thermal converters are suitable for operation, complete with microprocessors not yet sufficiently developed. It is necessary to analyze the principles of the hot-wire type converters in detail in order to select the optimal structure of the thermal hot-wire transducer suitable for use in the complete tube flowmeter further effective joint with microprocessor-controlled device. To this end, below analyzes the principles of the hot-wire transmitters and selection of optimal structures.

Technical characteristics of hot-wire flow meter

Measured	- water
Measurement range, speed	- 0-3 м/s
costs range for pipes up to 300 mm	
The above error	- 0-1 $м^3$/s
power consumption	- 2,0%
Supply voltage	- 10÷15
the medium temperature	- 220 V
Standard output signal with a load of 2 ohm	- 20±5 ^{0}C
The weight of the primary device without piping	- 0-5 мА
The weight measuring unit	0,6-0,8 kg
	- 2,5 kg

Designed flowmeter has a number of good qualities (sensitivity, simplicity of design, reliability, etc.). The proposed water meter has been tested for the control of water flow in pipelines and wells of vertical drainage [5].

References

1. *Кремлевский П. П.* «Расходомеры и счетчики количества: Справочник. — 4-е изд., перераб. и доп. — Л.: Машиностроение. Ленинград , 1989. — 406 с.
2. *Ташматов Х. К.* Расходомер воды в трубопроводе на основе тепловых преобразователей термоанемометрического типа. Москва. «Датчики и системы» №2, 2006, С. 37 – 39.
3. *Ташматов Х. К.* Тепловые датчики для систем управления насосной станции. Москва. «Датчики и системы». 2008, №4, С. 52 – 54.
4. *Ташматов Х. К.* Тепловые преобразователи для не разрушающего контроля параметров потоков газа и жидкости. Ташкент. «Standart» 2010, № 2, С. 26 – 27.
5. *Ташматов Х. К.* Многофункциональный термоанемометрический преобразователь параметров потока жидкости. Ташкент. «Standart» 2012, № 2, С. 29 – 30.