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THE THERMO-ANEMOMETRIC FLOWMETER

The necessity for fuel consumption control is becoming more and more important in automobile transport design. Flowmeters of various types are aimed to solve this problem and to avoid fuel misuse. Flowmeters are not only used for automobile and freight transport, but also for farm machinery (forklifts, harvesters, tractors and others), for special construction equipment, river and sea transport, buses, etc. There are a lot of fuel flowmeters available. Their classification takes into account parameters such as fuel type, presence and type of output (analog, impulse, and so on), data transmission system type, indicator availability, etc. The list of flowmeters in use includes: Coriolis, ultrasound, turbine, thermal, screw, piston, float, and magnetic induction devices. Every flowmeter, among those mentioned above, has its own particularities and drawbacks. Currently, the thermo-anemometric flowmeter (TAF) is considered one of the best devices for measuring the consumption of biofuels. Its main principle is to heat the fuel flowing to the engine, and to measure the distribution of the temperature field created by the heater in this flow. The changes of temperature field with engine fuel flow are determined by the definite functional dependence on fuel consumption value. That is why it is possible to determine fuel consumption with high accuracy by measuring the temperature field along the engine fuel flow axis. This makes the problem of thermo-anemometric flowmeter mathematical model development of current interest.

A thermo-anemometer is a device for measuring fluid flow speed. Its functioning principle is based on the dependence of convective heat transfer of sensor (S) on the flow speed, when the sensor is placed in the flow and heated by an electric current. The measuring bridge is the main part of a thermo-anemometer (Figure 1). This bridge has the sensor in one of its arms. The amount of heat, which is transferred by the heated sensor to the fluid flow, depends on the physical characteristics of the moving medium, piping geometry and sensor orientation. The higher the temperature of the sensor is, the higher the sensitivity of the thermo-anemometer is.

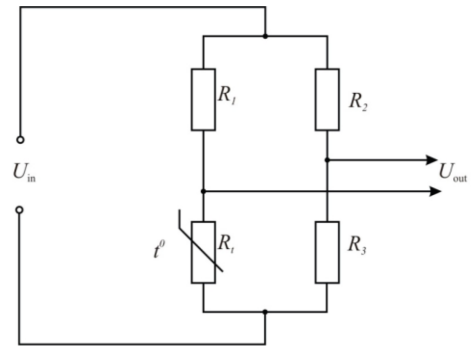

Figure 1. *Measuring bridge of a thermo-anemometer*
(t^0—the measured temperature).

Thermo-anemometers are classified according to the features which characterize the heat mode of the converter: the way of sensor heating (direct, indirect, continuous, and impulsive), the type of bridge current (direct, alternating), the type of electric circuit, etc. There are direct current and constant temperature thermo-anemometers depending on the converter heat mode. The bridge of such a generator is powered by a source with high internal resistance. It provides a constant current value at the sensor changing the resistance. Due to the fact that the temperature of the sensor changes with time, the band of recorded frequencies for non-stationary and turbulent flow is limited because of the sensor thermal lag. This causes a decrease of the amplitude of the signal at high frequency ω pulsations of times, where τ is the time constant of the sensor. Thermo-anemometers of the hot wire type use a very fine wire on the order of several micrometers, electrically heated up to some temperature above ambient. Fluid flowing past the wire has a cooling effect on it. As the electrical resistance of most metals is dependent upon the temperature of the metal, a relationship can be obtained between the resistance of the wire and the flow speed.

Several ways of implementing this exist, and hot-wire devices can be further classified as constant current anemometers (CCAs), constant voltage anemometers (CVAs) and constant-temperature anemometers (CTAs). The voltage output from these anemometers is thus the result of some circuit response within the device trying to maintain the specific variable (current, voltage or temperature) constant, following Ohm's law.