

NEW YORK City College of Technology

Electrical and Telecommunication Engineering Technology Department



Assignment # 3

EET 3120 Sensors and Instruments

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A SUMMARY OF FLEXIBLE FLOW SENSOR SYSTEM AND ITS CHARACTERISTICS FOR FLUID MECHANICS MEASUREMENT

There are different types of sensors, and the measurement of fluid mechanics is very important in various industrial fields. Among the sensors, flow sensor have been widely applied to execute accurate and efficient measurements. As a result, the interest in measuring of fluid mechanics is very important in various field in engineering and industries. “A flow sensor is a device for sensing the rate of fluid flow. Typically a flow sensor is the sensing element used in a flow meter, or flow logger, to record the flow of fluids. As is true for all sensors, absolute accuracy of a measurement requires a functionality for calibration.” The silicon-based flow sensor was first demonstrates in 1974 and since then many application were created after flow sensors such as: Thermal Anemometry, Doppler frequency shift, and indirect inference from pressure differences. Among these sensors, thermal flow sensor possess merit of simple structure and easy to use and also offer many particle solutions for various fluids application.

Thermal flow sensor working principle relies on the detection of the convective heat transfer between an electrically heated resistive sensing element (hot-wire or hot-film) and fluidic flow. They both experience cooling due to heat transfer given that the sensor is heated to higher temperature. Hear transfer depends on the flow velocity. Flow sensing is accomplished by monitoring the resistance change with temperature.

Polyimide as substrate was chosen because the thermal conductivity of polyimide and magnitude is lower than that of silicon. The thickness of the polyimide substrate is roughly 150 μm due to standardization concerns and this satisfy the requirement of mechanical rigidity. When combining multi sensors to form an array system, the distances between the sensors need to be well-designed to prevent any interference from each other. There are several procedure to take place while examine the characteristics of a flow sensor. Sensing element, fabrication, and post treatment to be performed in order to make the sensor more stable and durable. Although, some error may occur during the process like linearity relation during the heating process and stability during the electrifying process. The resistance of the sensor changes as the electrifying increased and it becomes stable when the electrifying reaches is maximum. Both hot-film/hot-wire sensor can be operated in constant voltage (CV), constant current (CC) and constant temperature (CT).

The hot-film sensor feedback system can be regarded as a semi-second-order system. The overshoot and the response speed are two conflictive parameters in the system. A tradeoff must be achieved here according to the application requirements. Due to its strip profile, the hot-film sensor is also sensitive to the direction of fluid flow. Under a sufficiently large aspect ratio, the yaw response of the hot-film sensor follows the cosine relation.

Flow rate range 0–15 m/s (α = 0.03) Angular sensitivity range 0–60º

TCR 2,000 ppm/°C Inaccuracy ±3% F.S.

Repeatability ±0.3% F.S. Response time *τc* = 72.8 *ms* (*G* = 250, α = 0.03, 9.8 m/s）

Zero adjustment Overheat ratio dependent

Supply voltage 8*VDC* ± 10% Output signal 1.5 V–4.5 V

Resolution 0.1 m/s Power consumption 30 mW(*G* = 50, α = 0.03, 5 m/s)