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A DESIGN OF AN AIRFLOW VELOCITY SENSOR FOR A COMBUSTION ENGINE¹

Tibor Bugár*, Aurel Sloboda*, Bohumil Horák**, Radovan Hájovský**, Stanisław Sosnowski***

*Technical University, Košice, Slovakia **Technical University, Ostrava, Czech Republic ***University of Engineering and Economics in Ropczyce, Poland

Summary. This paper deals with a design suggestion of a sensor for airflow velocity measuring. This sensor is necessary for an exact determination of the sucked-air amount. According to the airflow value it is possible to inject the correct amount of fuel into a combustion engine.

Key words: engine, sensor, air rate

INTRODUCTION

The suction system of a piston combustion engine has to deliver a necessary amount of fresh fuel-air mixture filling into a cylinder. The optimum amount of fuel-air mixture requires a correct proportion between air and fuel, i.e. the correct λ -value. From this reason it is necessary to measure the amount of sucked-air during current engine operation [Kraftfahrtechniches Taschenbuch, Bugár and Sloboda 1999, Bugár *et al.* 2003a]. This information presents basic input information for an engine electronic control system, i.e. for motor-management system. Another input signals are for example engine temperature, throttle position and composition of exhaust gases. According to the above-mentioned input signals it is possible to manage output engine parameters – revolutions, power, acceleration, etc. Each of the input signals requires an individual sensor for a reliable functioning of the engine electronic control unit. This involves the sensing of the sucked-air velocity.

MATERIALS AND METHOD

The sensing of the sucked-air velocity is necessary for an exact delivery of fuel, i.e. for the creation of a proper fuel-air mixture. Our paper presents a real sensor applied on

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a small-volume experimental engine with an extra-low fuel consumption. The engine works at the interval of revolutions from 2500 to 12 000 min⁻¹ with power up to 700 W [Bugár *et al.* 2003b, 2004]. The sucked-air is flowing through a specially shaped suction piping. The mass of the sucked air is proportional to the volume of air. Therefore if the air velocity and cross-section of suction piping are known, it is possible to calculate the volume of streaming air per time unit, i.e. the amount of sucked fresh air.

There are several methods how to measure the streaming air velocity. We applied the method of glowed wire with constant current. This glowed wire is cooled by streaming air in suction pipeline. Wire diameter is 0.035 mm and it is shaped into a small V-lattice in a hole d = 30 mm, Fig. 1.

There was performed a measurement on a testing stand for variable throttle position at various revolution levels with steps every 500 min⁻¹. The value of constant fuel injection pressure was 300 kPa. The amount of injected fuel depends on opening time of injection valve. There was performed a measurement on a testing stand for variable throttle position at various revolution levels with steps every 500 min⁻¹. The value of constant fuel injection pressure was 300 kPa. The amount of injected fuel depends on opening time of constant fuel injection pressure was 300 kPa. The amount of injected fuel depends on the opening time of injection valve.



Fig. 1. The airflow velocity sensing element

RESULTS

The opening time t_v of injection valve EV6 Court BOSCH is a very important time value for a proper amount of the injected fuel. Airflow velocity in suction piping is a function of sensor voltage $v = u^2$, thus the valve opening time is:

$$t_v = k \cdot v = k \cdot u^2, \tag{1}$$

where:

u – input voltage from airflow velocity sensor.

This voltage presents an input signal for an A/D converter. Characteristics of sensor output signal is a function of airflow speed according to the relation:

$$u^{2} = C_{0} + C_{1} \cdot \sqrt{v} , \qquad (2)$$

where:

 C_0, C_1 – invariables.

The characteristics of t_V was created, see Fig. 2. After the setting-up of correct t_V characteristics into a microprocessor the experimental engine was able to work with sufficient reliability.



Fig. 2. Behaviour of constant k for the calculation of valve opening time t_v

Constant k is non-linear at full engine power level with regard to A/D converter sensibility. This disadvantage had to be corrected by means of a special correction block. By means of this block it is possible to optimise the calculation of valve opening time. Another function of the described sensor is a measurement of the sucked-air temperature. The placement of the sensor is visible in Fig. 3.



Fig. 3. Position of sensor in suction piping of experimental engine

CONCLUSION

It was necessary to suggest and to produce the above-described sensor of sucked-air amount for our experimental engine by means of our own possibilities. Such kind of sensor for small-volume engines cannot be obtained on the current market. The correct function of sensor as well as function of engine were verified during an engine test operation at revolution level above 3000 min⁻¹. Fuel consumption of our combustion engine was reduced in this way, too.

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