Adjustment and Diagnostics of the System for Gas in Motor Vehicles

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Abstract **– The possibilities in programming and diagnostics of the performance of the system for gas injection, applied in vehicle with bi-fuel system, are presented in the paper. Performed investigations were aimed at indicating the advantages of particular systems. The possibility for applying thermal camera in diagnostics of the system for gas performance was investigated.**

Keywords **– Gas, programming, diagnostics.**

I. INTRODUCTION

All the vehicles which use liquid fuels can be adapted to application of gas, in bi-fuel systems. Application of bi-fuel systems on petrol engines is a long-term decision. The main property of these systems is that the engine is activated either by petrol or gas, according to attuned device, driver's preference or available fuel.

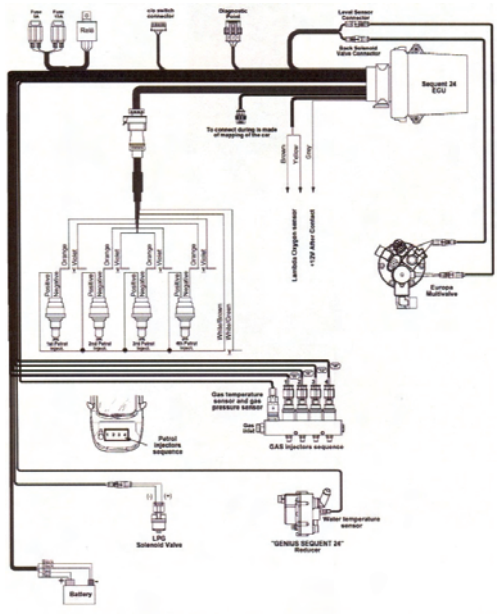

Fig. 1. Electric scheme of system for gas

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Fig.1 shows the scheme of one system for gas injection which consists of the following important elements: electronic control unit, selector of fuel type, gas filter, gas pressure regulator, unit for gas injection (injectors) and sensor of gas pressure/temperature. Another electronic unit for gas is added to the existing electronic unit of the system for petrol injection and is connected to it. System for gas injection is the system of the new generation of dual systems (petrol – gas). According to the defined procedure, the engine starts functioning with petrol at start and after a certain timing or achievement of given temperature the control unit switches the engine to functioning to gas. The electronic control unit for gas functions on the principle of calculating the gas injection timing, which is applied on gas injectors. Control of engine functioning is given to petrol control unit, while electronic control unit for gas converts such information into suitable control for gas. Some producers' electronic control units for gas calculate the gas injection timing by using specific information, such as: pressure in gas injection unit, gas temperature, cooling liquid temperature, number of engine revolutions, as well as input data of petrol electronic control unit.

II. ADJUSTMENT OF SYSTEM FOR GAS

When programming the electronic control unit of the system for gas injection, auto-calibration, recommended by the system producer, is usually used for initial adjustment of the system. The auto-calibration procedure, as well as the amount of data used thereat, can vary significantly, which is conditioned by: the system price, regulations of the country-installer, importers' demands, demands of the service provider, demands of the market, i.e. certification organization, system possibilities, i.e. device quality etc.

For investigation of the influence of programming of sequential systems for gas without auto-calibration, the system Sequent 24 of company BRC [4] was used, which does not provide the auto-calibration option; instead, adjustment of the system is realised according to the procedure defined by the producer. The initial adjustment includes adjustments at:

- idle
- idle with extra load (light, air-conditioning etc)
- at 3000o/min, with load.

The initial adjustments are realized at a standstill, after installing the system in the vehicle, i.e. after installing the system on engine in given case, with the adjustment results shown in [3]. The following interventions on the investigated system are possible in the case of system programming optimization:

- at idle
- with load.

The system for gas Sequent 24 of company BRC does not allow other options in the adjustment procedure, see Fig. 2[3]. That fact can be facilitating for a less demanding installer, but quite limiting in developmental system optimization. The results of realized investigations showed that there are not many possibilities in the optimization process of such a system. Consequently, the price of such a system is considerably higher than the price of sequential systems of other producers.

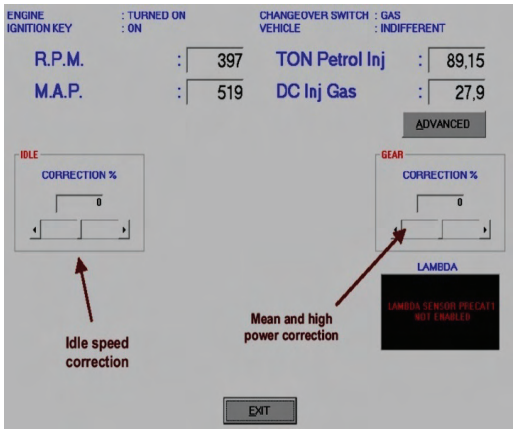

Fig. 2. Allowed adjustment of the system of company BRC

In systems with auto-calibration the initial adjustments are realized at a standstill, too, after installing the system for gas in vehicle. In general, the adjustment of system configuration is realized when the engine is not working. After that the auto-calibration procedure is started, where adjustment is performed according to the demand of the system producer. After the completion of auto-calibration procedure, each system will define its system map. The map is constructed on the basis of two pieces of data: engine rpm and petrol injection timing.

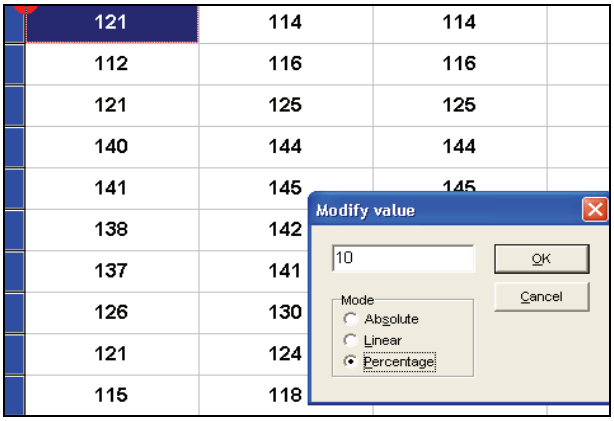

Fig. 3. System optimization

In case that you are not satisfied with auto-calibration, possible modifications can be realized by optimization of map value on gas, i.e. map coefficients loaded during automatic calibration process, both at minimum and beyond idle stroke range. In order to modify the values, you simply mark one or several fields, press ENTER on the keyboard, after which three options for correction will appear: absolute, linear and in percents (see Fig. 3). After selecting "**Switching from PC**", the new icon - "**Switch**" - will appear on the right side, which enables direct control of switch for gas, in the investigator's cabin, via computer. When testing the vehicle on the road, simply click on Switch in case that you wish to switch from petrol to gas or from gas to petrol. When you complete the testing, click on "**End switching from PC**", see Fig. 4.

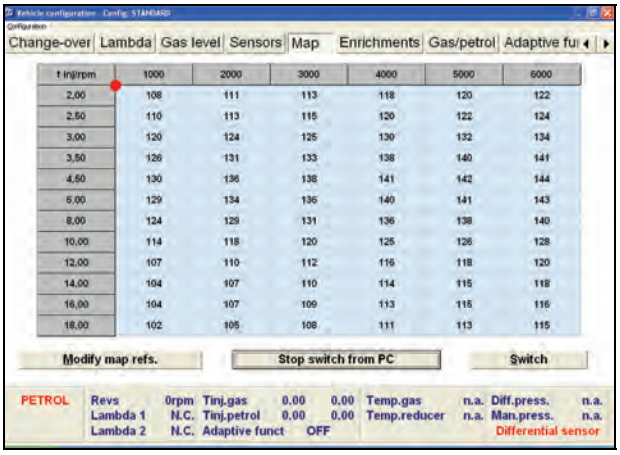

Fig. 4. Optimization – at a standstill or on the road

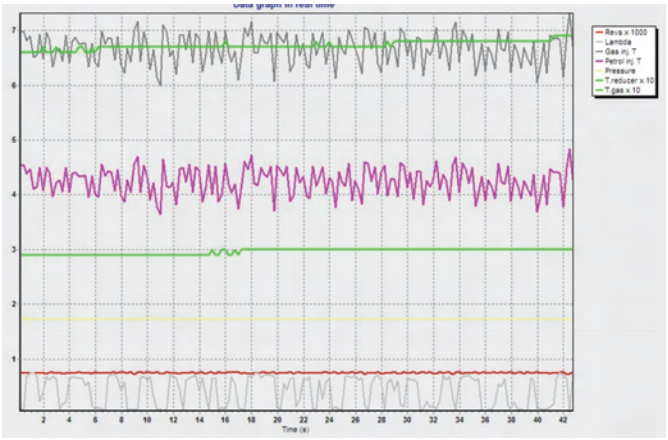

Fig. 5. Results of adjustments at idle stroke

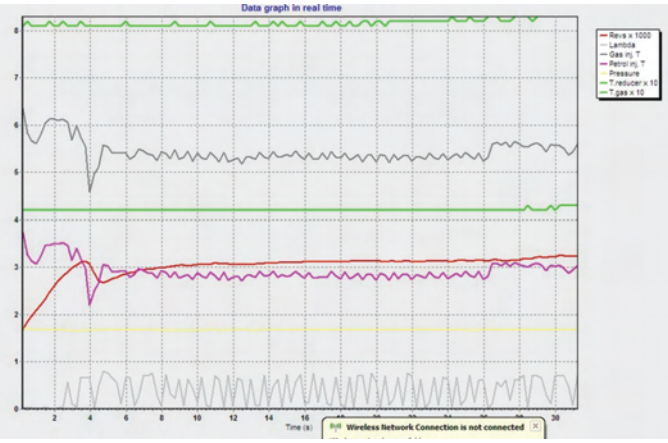

Fig. 6 Results of adjustments at 3000o/min

III. ADJUSTMENT RESULTS

When programming the ECU, in systems with auto-calibration, the auto-calibration procedure, as well as the amount of data used by ECU, varies considerably. Fig. 5 and 6 show the results of adjustments at a standstill. The effects of adjustment can be monitored on the computer for gas. Concurrent petrol injection timing and gas injection timing were obtained. In addition to the analysis of effects of adjustments via computer, attention must be given to the functioning of engine in these conditions, whose running must be constant and uninterrupted. After that, the correction effects are checked on the track in the following conditions:

- vehicle acceleration (I-IV gear)
- vehicle elasticity.

The results of vehicle behaviour check are shown in Fig. 7 and 8. In the course of testing, there must be no interruptions of engine running.

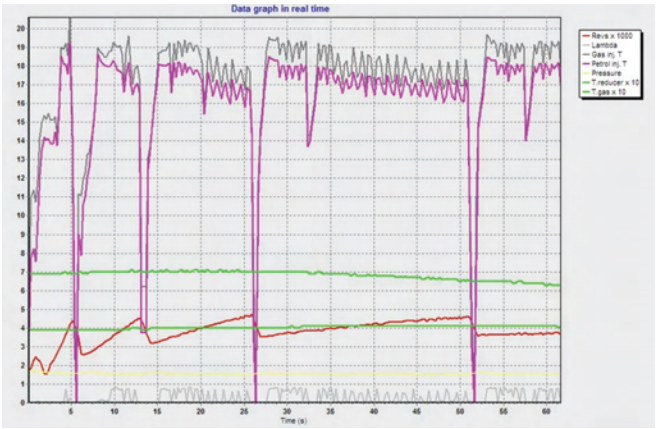

Fig. 7 Vehicle acceleration

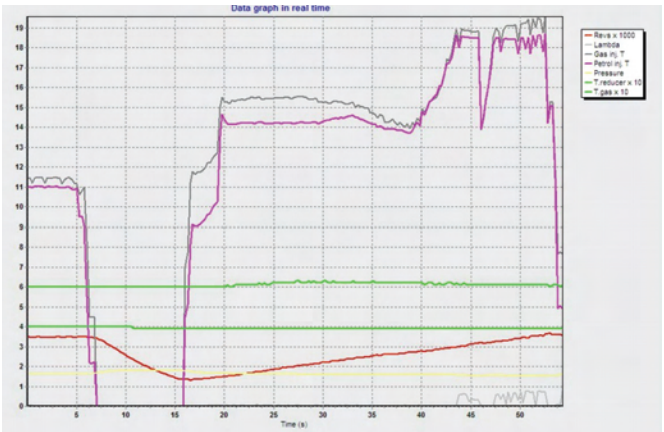

Fig. 8 Vehicle elasticity

Additional adjustments require a lot of time even for the experienced adjuster. In serial installing of the system for gas it is not enough to monitor the effects of adjustments only on the computer for gas. Fig. 9 shows the results of measured power on wheel, petrol-liquid petroleum gas comparatively, in one well adjusted system. Small degradation of vehicle power is obtained when applying gas as fuel. Fig. 10 shows the results of comparative petrol-LPG acceleration measuring. Also, insignificant deviation of vehicle properties was obtained at gas application. Adjustment effects are different for different systems.

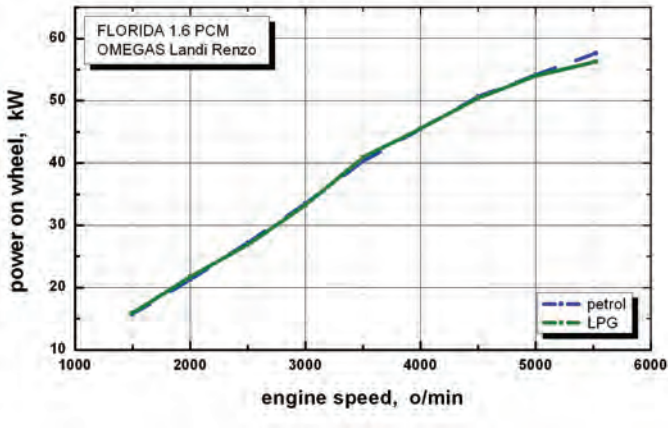

Fig. 9 Comparative presentation of power measuring results

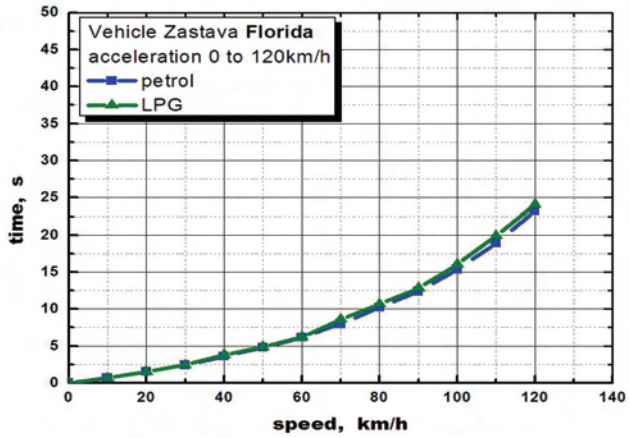

Fig. 10 Comparative presentation of vehicle acceleration measuring

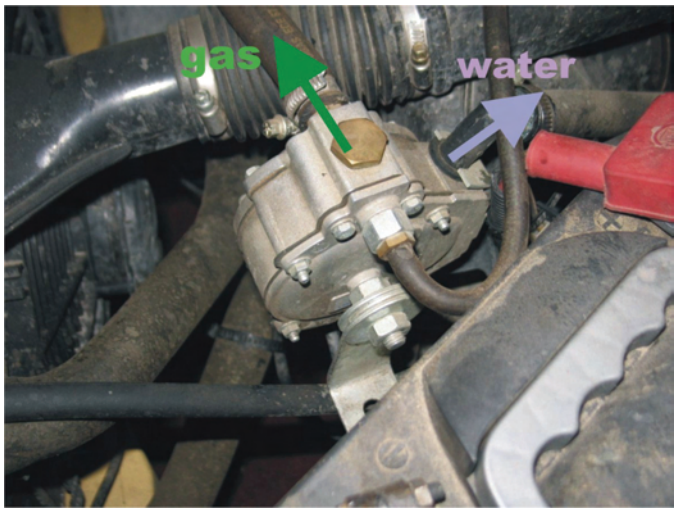

Fig. 11 Position of the pressure reducer in engine compartment

IV. APPLICATION OF THERMAL CAMERA IN DIAGNOSTICS

In most sequential systems, on of the parameters which can be monitored on the computer is gas temperature, see Fig. 6 and 7. Gas temperature is highly influenced by the position of pressure reducer, both in relation to other elements of the system for gas and the drive unit in engine compartment. In the designing process, the rules for installing the pressure reducer must be obeyed (regarding height, width ...). The position of one pressure reducer is shown in Fig. 11. On account of need for quick diagnostics and monitoring of gas behaviour in pressure reducer, i.e. monitoring of gas temperature change, the paper presents one of the possibilities in application of thermal camera in diagnostics, see Fig. 12.

Fig. 12 Application of thermal camera in diagnostics of system for gas

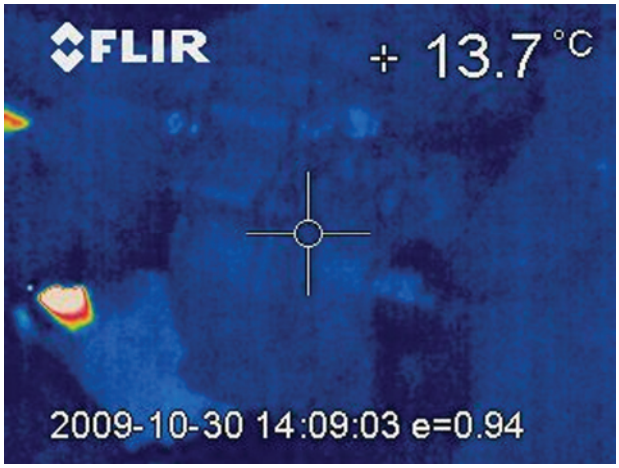

Fig. 13 Cold start

In case that the thermal camera is applied in diagnostics of pressure reducer functioning, the engine compartment must be open, similarly to the conditions of adjusting the system for gas at a standstill. Thermal camera can only be used when the vehicle is stationary, in conditions of idle stroke or at 3000o/min. The application can be customized to the system adjustment conditions, as it is the case in most private service-stations which install system for gas. In addition to that, thermal camera can be used for analyzing heat load of each element in engine compartment.

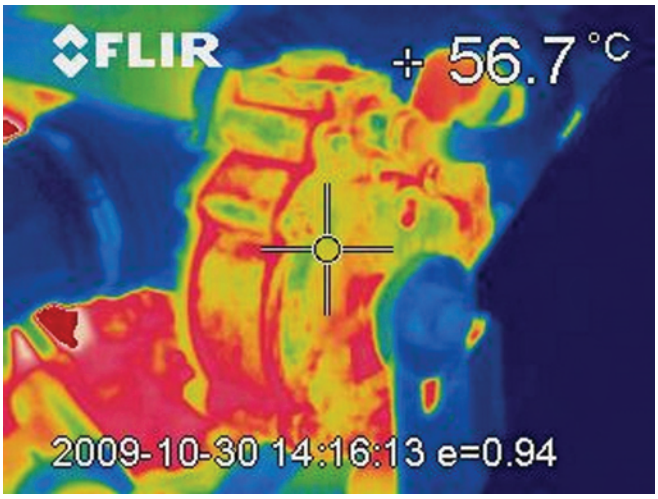

Fig. 14 Fifth measuring

In addition to pressure reducer heating, we can monitor the heating of other elements in the surroundings comparatively. After completion of this measuring, we can check the heat load of all other vehicle elements.

V. CONCLUSION

The results of investigating the effect of system for gas injection programming are presented in this paper. Additional adjustments of the system require a lot of time and adapting of gas ECU to petrol ECU. In the course of that attention must be paid to the speed of electronic control units adaptation to functioning on petrol and gas. Thermal camera can be used for fast analyses of system elements behaviour under heat. Data obtained in this way are useful and specific.

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