Experimental design for *Diesel supply control* in order to improve fuel efficiency

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Abstract. The experimental testing and development of a system integrated in a vineyard farm in order to improve fuel efficiency of transport vehicles is a valuable asset and a way to go in the current research effort. The present paper is aiming to study and to present the practical application of equipment and ideas for automatic monitoring of fuel level inside the vehicle's tank. The system is created by digital hardware connected to the vehicles in question and controlled with proper software application in order record and offer an applied image of fuel level status or evolution. Actual data are recorded with the software module. This research points to the automation technology in automotive engineering and transportation field for a better fuel consumption management. Vehicle's engines are supplied with Diesel fuel via a volumetric sensor. From the fuel tank to the common-rail system, particles of the Diesel fuel are monitored and data is sent to digital control station via internet cloud. The experimental research is developed to create an environment for precise Diesel supply control to power trains in order to generate the basis of improving the fuel efficiency.

1. Introduction

Fuel loses and improper usage leads to lower efficiency when it comes to consider the energy management. The necessity for a proper fuel consumption management and control resides in significantly high costs of energy. Through a complex approach of the automation procedure in fuel level control during operation and even in park mode, the present research shows a design in which vehicles are strictly controlled regarding fuel supply management. Other researches were conducted on more electro-mechanical level of approach in small engine applications [1]. Some of the previous studies were developed analysing the link between fuel supply and lubrication [2], on one hand, or engine operation and Diesel particle filter [3], on the other hand. Fuel consumption influences the carbon foot print [4], thus it is reasonable to study these relations and their further potential. Residual particles [5], fuel consumption management and pollution evolve with a certain proportion characteristic [6] leading to the necessity of redefining the transport vehicles and powertrains [7].

Control and actuation system are thoroughly studied nowadays in other to develop more adaptable robotic and automatic applications and systems, with increased energy efficiency [8]. Highly complex transportation activities generate complicated measures to be taken for improving operating conditions [9], with multiple parameters to be considered [10]. Recent developed studies are pointing out to latest technologies and various possibilities in management of the energy resources [11], as well as to the numerical investigation of some factors [12]. Engine starting procedure and cold temperature operation of the entire power train lead to the possibility of influencing both the fuel consumption and the exhaust pollution [13][14]. Main objective of the paper is to present the implemented technology regarding the fuel consumption control with automatic reporting application on seven vehicles in

Jidvei area. As a part of the strategy to reach this stipulated target are nine specific objectives through which particular sequences are reached. These specific objectives are as follows: installation of the Titan Farmis application on the Jidvei digital platform; connecting the electronic platform with the mobile equipment; drawing the connections of the volumetric sensor with the proxy equipment; defining the experimental design for Diesel supply management; practical intervention and actual placement of the sensors and equipment on the studied vehicles (connections and adjustments); defining and applying the proper methodology for networking the vehicle and the server; location monitor and vehicle units' identification; vehicle speed control via the automatic reporting application; graphically representation of fuel tank level and control of supply. Thus it may be useful integrating some features and function based models into de application for experimental design of a diesel supply system with control possibilities in order to improve fuel efficiency.

Using Titan Farmis application it may contribute to a strictly monitoring the vehicle operational features and characteristics. This application is acquired together with other equipment necessary for this experimental endeavour.

2. Methodology and material

Through application of digital processing and automation capabilities available today in computational sector and internet, there may be defined an engineering method with specific instruments for Diesel fuel supply control in one digitally integrated system. In order to control the engine there is necessary to locate the fuel tank access for placing the fuel volumetric sensor. Specialized connection is linking the electronic control unit for the volumetric sensor with computing station, according to figure 1. Separated wires and digital unit were individually matched and connected in order to establish communication. Taking into consideration the problem of fuel control with vehicle powertrain allows the researcher to define a wide range of features that may be implemented in order to positively impact the energy efficiency and diminish carbon footprint. The present research use as material the power train as fuel consumer, the volumetric sensor for fuel tank level, electronic equipment, a network connection and software programs. The methodology consists in experimental application and set up of digital devices which offer the control possibilities regarding fuel level variation in real time and remote digital recording of the real values.

Multiple fuel level sensors are tightly placed inside the fuel tank of each one of the seven vehicles involved in the present study. The measuring pipe of the fuel level sensors must be permanently placed in the fluid inside the fuel tank. Digital unit of the sensor is placed in the upper part on the surface of the fuel tank of each vehicle considered in experimental part.

Connections and relations between the system parts that participate in the overall operation are sketched out in figure 1, in which may be observed the intricate influences of each factor.

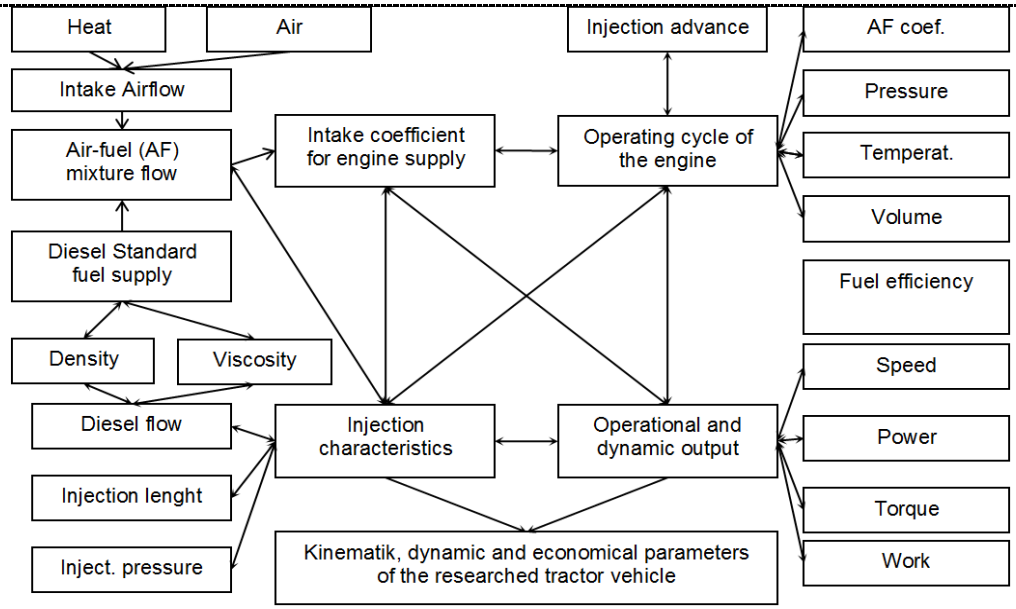

Figure 1. Schematics of the experimental designed methodology applied for Diesel fuel supply control and management during the practical part of the conducted research at Jidvei vineyard

3. Experimental results and discussions

With materials and by applying the specified methodology, the experimental part develops as planned and results are recorded.

In order to properly test in experimental conditions the equipment acquired and placed on all the vehicles took into consideration for the present research a finite small track was set up, as shown in figure 2, on which the vehicles were moved incrementally for the calibration procedure of the fuel control system.

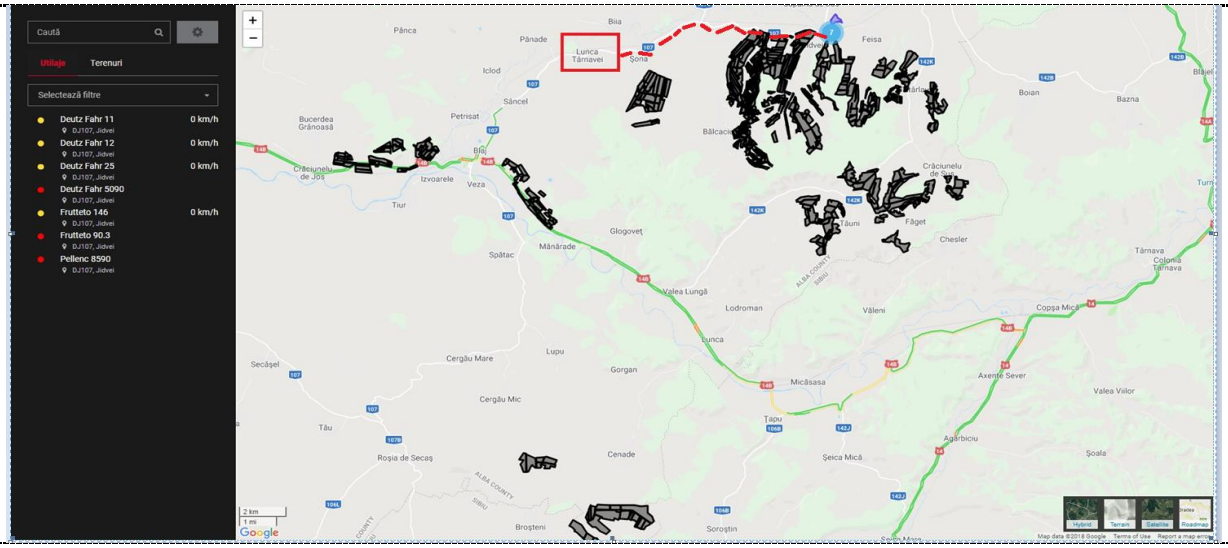

Figure 2. Geographical definition of the track between two locations in the experimental research log.

In the left side of the control panel are placed and numbered all the seven vehicles which were under the observation during the present experimental research development. Deutz Fahr, Frutteto and Pellenc vehicles were considered and studied. The actual track represented with red interrupted curve up side of the map is connecting the Jidvei city with Lunca Târnavei, both linked by 107 DJ road.

First thing before complete measurements and testing there was put in action the calibration on site procedure for all the vehicles took into study, thus some manoeuvres back and forth were made, as

captured in experimental part, showing an increase of speed and a full stop afterwards. All data were recorded for further study.

Following the calibration step there was the measuring procedure with all the vehicles fully equipped and data transfer process in complete operation. Graphical and numerical representations are recorded and stored in digital programme installed on the Jidvei software platform.

The simplified data sheet with some technical references is given in table 1, showing the accuracy level, followed standard and available / used devices.

Table 1. Technical specifications of the control station for exhaust emissions recordings and study.

Parameter	Exhaust control station
Accuracy deviation level	0
Compliance standard	OIML R99
Tachometer	BDM (B+/B-)
Smoke meter	RTM 430
Gas analyse	CO, CO2, HC, O

The application and the systems were in full operation and completely automatized receiving and transmitting data between interconnected equipment in real time, and offering at request valuable reports on fuel efficiency on each individual vehicle took into consideration. By accessing the interface presented in figure 3 all the digital reports, both individually compiled or complex simultaneous comparisons are available. Thus specialized experimental design for Diesel supply control system was implemented to further improve fuel efficiency in practice of everyday operation of Jidvei farm tractors and machineries.

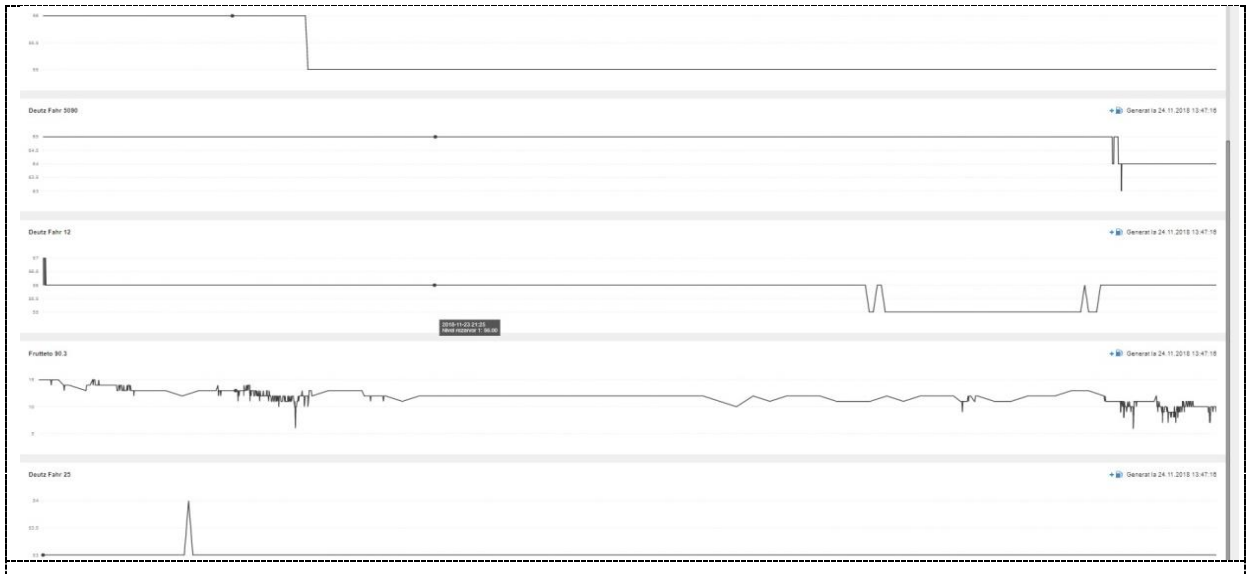

Figure 3. The electronic signal received from the fuel level sensors and recorded in Titan Farmis app.

Most fundamental parameter, that is important for consideration in mathematical modeling of the fuel flow and consumption efficiency, consists in *fuel hourly consumption*, given by the relation [7]:

$$F_{HC} = 3600 \bullet F_{inj.vol} / \tau, \quad (1)$$

where F_{HC} is hourly consumption of the fuel in [cm^3/h]; $F_{inj.vol}$ - fuel injected volume measured in [g]; τ - time in which there was injected the fuel in combustion chamber in [sec.].

4. Conclusions

In the presents research, were studied the possibilities and actual steps of implementation in Jidvei Vine Farm for a complete digitalised and automated system for fuel level control and energy consumption management in order to further improve the power train efficiency and lower the carbon footprint. Although the overall fuel efficiency improvement is a highly complex result after many hours of operation, which was not the main target of the present work, it may be still be assessed that by proper use of the automatic system there will be such an improvement in energy supply and work.

The highest variation in fuel level recorded on the platform was from the Frutteto 90.3 mobile unit. There were also induced oscillations in fuel level inside the tank in order to simulate and record abnormal activities on some of the other vehicles in question. System worked as expected and returned result in practice. Experimental research is still applicable on other aspects in order to assess more definitely the consumption for each operation in particular in order to map properly the pollution.

Acknowledgments

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