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Fuel Dispenser Control System as the Technical Solution for Preventing Non-Authorized Fuelling

Abstract

Enterprises engaged in urban and suburban public transport, as well as other transport enterprises, big fuel consumers, needs control of fuel delivery to prevent and/or minimize misuse of fuel. Evidences of fuelling of vehicles, total fuel delivery of pump-stations, drivers of the vehicles, and staff of the pump stations are performed to collect data for different analyses. Such analyses makes possible to analyze vehicle technical condition, eventually misuse of fuel etc.

The paper presents one possible technical solution of the systems for fuelling control, based on RFID technology, system ITGfdc-1. Both, the technical aspects and procedure of fuelling are discussed.

This technology could be applied for all enterprises that have their own fuel pumps, but also for other fuel pumps that supports cashless payment.

Key words: RFID, control system, public transport, transport, fuelling

Enterprises, which are big consumers of fuel, frequently have their own gas stations for supplying of their vehicles with fuel. This specially weighs for enterprises which are engaged in urban public transport, taxi associations, transport enterprises etc. In such conditions a variety of evidences are performed, starting with evidences of total fuel delivery of the pump station, to the more specific records concerning fuel consumption sorted by vehicles, drivers etc. Comparing the records, it is possible to notice that some of delivered fuel does not end in the engines of the assigned enterprise's vehicles. Non-authorized assumption of fuel is one of possible causes of losses, and any firm has an interest to work on its moderation. One of possible methods is conduction of detailed records about that who and when was included in process of fuel distribution. Also, it is necessary to record vehicle in which the fuel is infused. That way all of the participants are visible and by using of statistical and other analyzes it is possible to point out the problems in fuel consumption and delivery.

One of possible solutions for named problems could be application of technical solutions with reduced influence of the human factor, the solution with automatic data acquisition and recording. Following the idea, technical solution for fuelling of buses of city public transport company JGSP "Novi Sad", Serbia and Montenegro, named ITGfdc-1, was developed and applied.

Intent

ITGfdc-1 system makes possible fuelling only to specially marked vehicles as well as data acquisition of relevant fuelling parameters by using RFID (Radio Frequency Identification) technology to identify vehicle, driver and other information about vehicle and its owner. It can be applied to most of the existing fuel dispensers, from which system collects information about volume of tanked fuel.

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The system prevents non-authorized fuelling and provides secure and reliable administration of fuelling procedure, thus minimizing human errors and saving time.

System is intended for users that have their own gas station, like transport companies, as well as for:

- Gas stations which issue loyalty cards and
- Gas stations with cashless payment.

Fuelling scenario is defined according to user category and rules of operation.

Technical Solution
- System consists of:
- Vehicle identifier,
- Driver's and pump attendant's ID cards,
- Dispenser controller **ITGkp-02,**
- Master computer and
- Application software for monitoring fuelling.

Vehicle identifier, RFID transponder, has disk shape (20mm in diameter, 2mm thick). It is mounted in appropriate way near the fill pipe (Patent pending). Identifier has relevant data about vehicle, such as: license and/or garage number, fuel type which vehicle is using, etc. Identifier has its unique read/only ID number (32 bits long) and 256 bytes of EEPROM memory ("read-write" memory type).

Hitag-S RFID transponders are used as transponders throughout the system: vehicle identifier, driver identification cards (ID cards) and pump attendant ID card. Pump attendant is an option, as the system can be set up with unattended gas stations as well. All transponders are passive elements, without power supply, what minimize maintenance requirements.

Gas pump controller ITGkp-02 is developed as dedicated control/monitoring computer, based on microcontroller. It supports RFID transponder readers with several antennas, gasoline pump interface and communication channel to monitoring computer (standard PC). Antenna which is used to identify vehicle, is mounted on the dispensing nozzle spout and consists of inductor coil, passive electronic components, sealed in special material approved for use in hazard environments (Fig. 2).
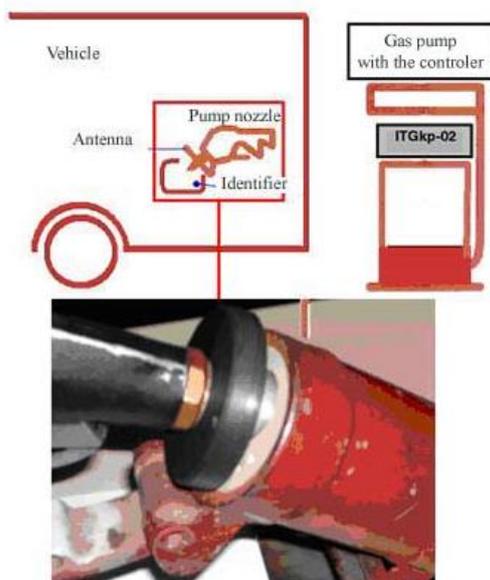

Fig. 1 Gas station of the company JGSP "Novi Sad"

Fig. 2 Pump nozzle with antenna for vehicle identification

Fig. 3 ID card reader's antenna   Fig. 4 Detailed view of ID card reader's antenna

Antenna is connected to RFID reader with special cable. Second antenna is used to read driver and pump attendant's ID cards. Antenna of the reader is placed behind glass, and it is unreachable from outside. Actually, antenna is placed in glass box of the gas pump, near counters (Figs 3 and 4).

Reader controls antennas and pump operation like allowing/forbidding fuelling as well as storing all relevant data in its memory, such as:

- Unique serial number of the driver ID card;
- Unique serial number of the pump attendant ID card ;
- Unique serial number of the vehicle identifier;
- Fuel type and amount which has been tanked into vehicle;
- Date and time of the operation.

If during fuelling pump nozzle is pulled out from vehicle filling pipe so that vehicle identifier disappears from identification's antenna field, fuelling is aborted.

One possible scenario in which fuelling will be allowed is:

- System has detected and read vehicle identifier
- System has detected and read driver's and pump attendant's ID cards
- Having these parameters and current date and time, system has consulted Authorization Table and got approval to start fuelling.

Authorization Table contains list of vehicle IDs, pump attendants and drivers IDs as well as time schedule of approved fuelling. System administrator creates and updates the Authorization Table.

Cashless payment system (prepaid or postpaid) i.e. loyalty cards solution, with ITGfdc-1 provides high quality of service as well as safe and secure administration.

ITGkp-02 is connected to monitoring computer (IBM®PC compatible) over RS232, RS485 or TCP/IP interface. Application software packet **ITG-TankControl** was developed using Microsoft® tools. It is used to set up working parameters of the ITGkp-02, to create and update Authorization Table, to read log from controller and to generate reports.

Step-by-step system operation:

- Driver drives his vehicle to the fuel station;
- Driver and pump attendant identify themselves with their ID cards, according to procedure set up by fuel station authorities.
- Pump attendant puts pump nozzle in vehicle filling pipe

- Antenna is activated automatically (digital input determinates which antenna should be activated and which fuel type should be tanked) and starts looking for transponder in their own area
- Transponder sends its serial number to antenna, which sends that number further to controller
- Controller checks validity of the received serial number, controller writes that serial number in reader's memory;
- Transponder sends data from its memory (vehicle's license number, fuel type, etc.) to antenna, which sends them further to a reader.
- Controller checks received data and if they are valid (ID numbers of vehicle, driver and gas employee are in the Authorization Table), permits fuelling and writes data with time and date in own memory.
- Fuelling is done as long as vehicle ID transponder is within the range of antenna on pump nozzle spout, whereby driver's ID card is placed on identification place.
- When fuelling is over, all parameters (transponder's serial number, amount of tanked fuel, time and date of beginning and ending of fuelling) are written to controller ITGkp-02 memory.
- When pipe is set back on its place, digital input switches off the antenna.

All administration is paperless, considering that all parameters are kept in electronic form and are sent to computer of the authorization person.

If parameters from transponder are invalid, or transponder is not mounted on the vehicle, or attempt of wrong type fuelling is made, or fuelling is not allowed for specific vehicle or driver and/or pump attendant do not have fuelling permission, alarm is turned on (sound and light signal).

In some accidental situations, when, for example fuel needs to be tanked into canister, barrel or something similar to be taken for field operation, a special (supervisor) card is used by an authorized person. Company determines rules for supervisor card usage.

Conclusion

Technology of vehicle fuelling through the RFID control system make possible collecting data of different actors in fuelling process, so it is possible to reduce losses of fuel connected with non authorized fuelling, and to protect property. Very positive results could be achieved by enterprises that have their own gas stations. In them the complete process of fuelling could be arranged by unique methodology, with a small number of different situations on the location.

System could be very efficiently applied on all gas stations that support cashless payment systems of fuelling as well. In that case, because of the number of users, their mobility and their protection against misuse of their ID cards, it is necessary to obtain infallible computer network, same as by cashless pay tool payment.

Bearing in mind opportunities of RFID technology, its flexibility and adaptability to different needs of people and property protection, it is to expect its extensive growth in the very near future.