Smart fuel control system

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ABSTRACT

The research paper intends to solve the public problems about fuel dealing. Some of the fuel station is selling with volume flow rate sensors based control system. In these control systems, since the amount of fuel depends on the environmental temperature, both of customers and dealers do not have a satisfactory and a convenience issues and have only the sensor effects. To get the advantages between the sensor based and time based fuel control system, the system was simulated with Proteus ISIS software and VB.Net. So the paper will get the good results to be convenience for the publics. Especially, the effects between the volume flow rate sensor and time based system will be known

Keywords *– advantages, volume, Proteus, sensor effect and temperature based system*

I. INTRODUCTION

Although the volume of the fluid cannot changed in nominal temperature, in nowadays, it is very important to adjust the problem for tropical zone. There are many fuel stations that used flow rate sensors. The volume flow rate depends on the environmental temperature. So the volume of fluid can be changed by the effect of the temperature. These stations cannot get the satisfactions both customers and dealers. Then it has a disadvantage depending on the temperature changes in oil storage tank. It was also a worst problem for the region which has so many temperature changes.

II. DEISNG CONSIDERATION OF THE TIME BASED SYSTEM

The octane volume can change depending on the temperature. So the volume compensation of octane is calculated in this section.

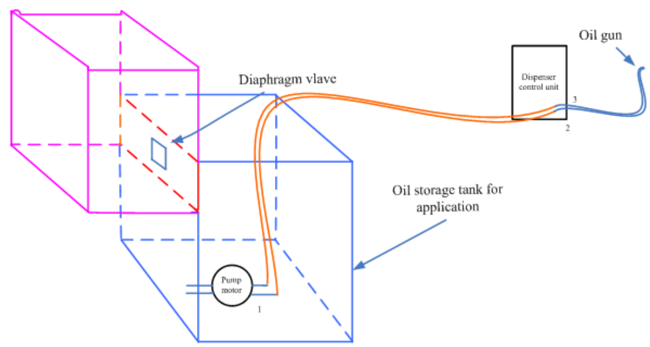


Figure 1. Sketch of fuel station

Table.1. Design specifications

1.	Pipe Length between pump and dispenser	L_1 (meter)
2.	Pipe length between dispenser and oil gun	L_2 (meter)
3.	Total height of the system = tank height + height From gun to the ground	H (meter)
4.	The suitable submersible pump	0.75Hp
5.	Pump efficiency	80%
6.	Pipe diameter between pump and dispenser control unit	$D_1 = D_2$ (meter)
7.	Pipe diameter between dispenser control unit and gun	$D_3=D_4$ (meter)

Octane of density at 15^{o}C, $\rho = 698.6\ kg/m^3$
$g = 9.81\ m/s^2$
Nominal flow rate: 600lpm to 1000lpm available: 3/4Hp, 1Hp or 2Hp.
The suitable pump 0.75Hp submersible pump with efficiency 80% is selected.
The flow rate of pump is calculated by using (1).

Power = $\gamma QH = \rho gQH$ (1)

$0.75 \times 746 \times 0.8 = 698.6 \times 9.81 \times Q \times H$

$$Q = \frac{0.067924}{H} \ m^3s^{-1}$$

The pipe diameter and flow rate between the pump and dispenser are the same. So the velocity can be calculated by using (2).

$$Q = A_1 v_1 \quad (2)$$

$$A_1 = \frac{\pi D_1^2}{4} = 0.7854 D_1^2 m^2$$

$$v_1 = \frac{Q}{A_1}$$

$$v_1 = v_2 = \frac{0.06792}{0.7854 D_1^2 H} = \frac{0.086478}{D_1^2 H} \ m/s$$

Pipe diameter between dispenser control unit and gun are the same.

$$A_3 = \frac{\pi D_3^2}{4} = 0.7854 D_3^2 m^2$$

By continuity equation, $A_2v_2 = A_3v_3$

$$\frac{\pi D_2^2}{4} \times v_2 = \frac{\pi D_3^2}{4} \times v_3$$

$$v_3 = \frac{D_2^2}{D_3^2} \times v_2 \ m/s$$

Flow rate, $Q = A \times \frac{s}{t}$ (3)

$$T_{delay} = t_{(pump\ to\ dispenser)} + t_{(dispenser\ to\ gun)}$$

$$\text{Delay time, } T_{delay} = \frac{A_1 L_1 H}{0.06792} + \frac{A_2 L_2 H}{0.06792}$$

$$= \frac{0.7854 D_1^2 L_1 H}{0.06792} + \frac{0.7854 D_2^2 L_2 H}{0.06792}$$

$$= 11.5636(D_1^2 L_1 + D_2^2 L_2) \text{ sec} \quad (4)$$

Initial temperature, $T_{ini} = 15$ºC

Temperature from the temperature sensor,

$T_{final} = X$ºC

Let temperature difference, $\Delta T = T_{final} - T_{ini}$

$= (X-15)$ ºC

Volumetric temperature expansion coefficient

$= 0.00114 m^3/m^3$ ºC

In order to get the desired density, the value of 1+ 0.00114 x ΔT must be first calculated.

$=1+0.00114 (X-15)$ ºC

Density at 15ºC, $\rho_{ini} = 698.6 \ kgm^{-3}$

Density at XºC, $\rho_{final} = ?$

$$= \frac{698.6}{1+0.00114(X-16)}$$

Volume at 15ºC, $V_{ini} = 1$ liter $= 10^{-3}$ m^3

if $m_{ini} = m_{final}$ (mass)

$$\rho_{ini} V_{ini} = \rho_{final} V_{final} \quad (5)$$

$$V_{final} = \frac{[1+0.00114(X-16)] x (698.6 x 10^{-3})}{698.6}$$

$= [1+0.00114(X-16)] \times 10^{-3} \ m^3$

$= [1+0.00114(X-16)] \times 10^{-3} m^3$

Volume flow rate of pump, $Q = \frac{0.06792}{H}$

1 liter, 10^{-3} m^3 = ?

$$= \frac{H x 10^{-3}}{0.06792}$$

$=14.7232 \times 10^{-3} H$ sec

Volume changes = $[0.001+11.4 \times 10^{-7}(X-16)]-10^{-3}$

$= [0.001+11.4 \times 10^{-7} X - 1.824 \times 10^{-5}] - 10^{-3}$

$= 11.4 \times 10^{-7} X - 1.824 \times 10^{-5} m^3$

For $11.4 \times 10^{-7} X - 1.824 \times 10^{-5} m^3$ the volume change of octane,

Compensated Time, $T_{comp} = ?$

$$= \frac{(11.4x10^{-7} X - 1.824x10^{-5})(14.7232x10^{-3} H)}{10^{-3}}$$

$T_{comp} = 0.016784(X-16) \times 10^{-3} H$ sec/liter (6)

let Y be the cost of octane for 1 liter.

If 1 liter = Y kyats,

Y kyats $= 14.7232 \times 10^{-3} H$ sec

1kyat = ?

$$= \frac{14.7232 \ x10^{-3} H}{Y} \ \text{sec}$$

Let Z = Customers request from the keypad (input amount)

Z kyat = ?

$$= \frac{14.7232x10^{-3} HZ}{Y} \ \text{sec}$$

In the control unit, unless flow rate sensors are used, the controller will control the time taken for the specified fuel volume including temperature effect. In order to control the time for the specified fuel, the total time equation can be calculated. So, for the software implementation of the system, the program is written by using Equation 4.16 to control the system correctly.

$$\text{Total time, } T_{tot} = \frac{14.7232x10^{-3} HZ}{Y} + T_{comp} + T_{delay}$$

$$= \frac{14.7232x10^{-3} HZ}{Y} + 0.016784(X-16) \quad x \quad 10^{-3} H$$

$$+ 11.5636(D_1^2 L_1 + D_2^2 L_2) \text{ sec} \qquad (7)$$

Where, Z = customers request from the keypad (input amount "kyats")

Y = the cost of octane for 1 liter "kyats"

X = the temperature of the octane from the temperature sensor "°C"

III. TIME CONTROL FLOW CHART

If the start signal is actuated, the controller continues to read the level sensor signal. The output graphic level will display depending on the status of sensor. And then, continue to read the keypad signal. In this system, 4x4 keypad is used. A keypad is simply an array of push buttons connected in rows and columns.

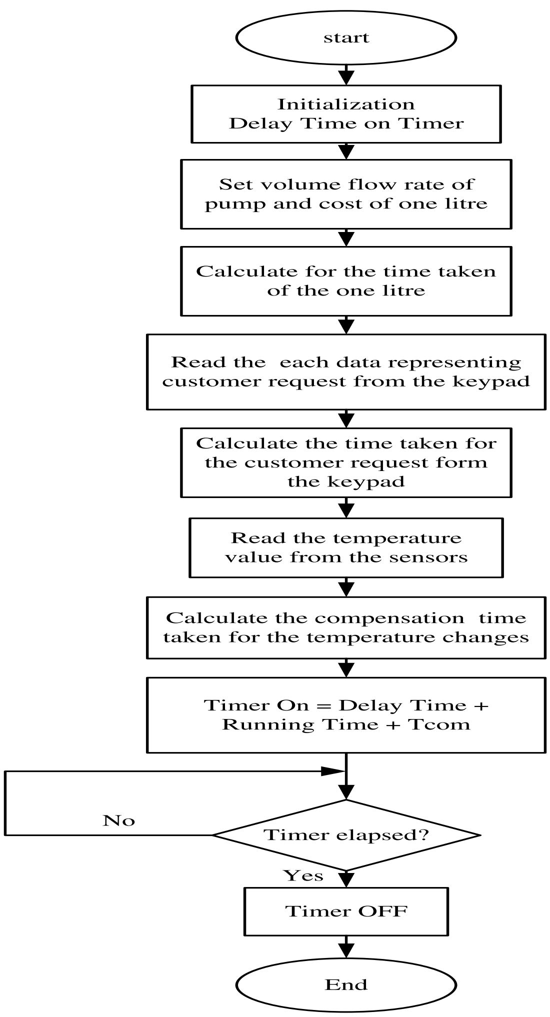


Figure 2. Time control flow chart of the system

IV. RESULTS OF THE SYSTEM

These results depend on height from tank to dispenser and customers request from the keypad. Table.2 shows the time results of the Octane without compensation.

Table 2. Densities and compensated fuel amount of octane depending on the temperature

Temp:, X(°C)	Density changes	Volume at X(°C)
16	698.6000000	1.0000013
17	697.8045029	1.0000014
18	697.0108153	1.0000015
19	696.2189313	1.0000016
20	695.4288445	1.0000017
21	694.6405489	1.0000018
22	693.8540384	1.0000019
23	693.0693069	1.0000021
24	692.2863485	1.0000022
25	691.5051571	1.0000023
26	690.7257267	1.0000024
27	689.9480514	1.0000025
28	689.1721253	1.0000026
29	688.3979425	1.0000027
30	687.6254971	1.0000029
31	686.8547832	1.0000030
32	686.0857951	1.0000031
33	685.3185269	1.0000032
34	684.5529730	1.0000033

At first, LCD and UART are initialized to begin the system process. And the controller will wait the start signal from the serial port. The statuses of pump motors are controlled by the start signal from the computer.

In this control system, the main control station is the computer. Only the allowable signal from the computer is got, the controller continues to control the process depending on the gun switch. The "unlock" condition of the controller is displayed on the LCD.

When the start signal is sent from the computer, the welcome message will be displayed on LCD and then pump is ready to pump the fuel depending on the gun switch. And then the costs of the desired fuel must be entered from the keypad.

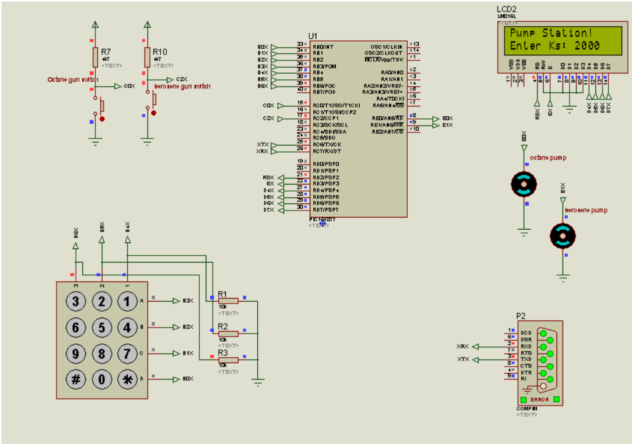


Figure 3. Simulation Circuit of the System

This "full fuel tank function" depends on the gun switch condition. When the gun switch is pressed, the controller will calculate the fuel cost and fuel amount with respect to time. VB.Net Simulation with Full Fuel Tank Function is displayed in Fig.4.

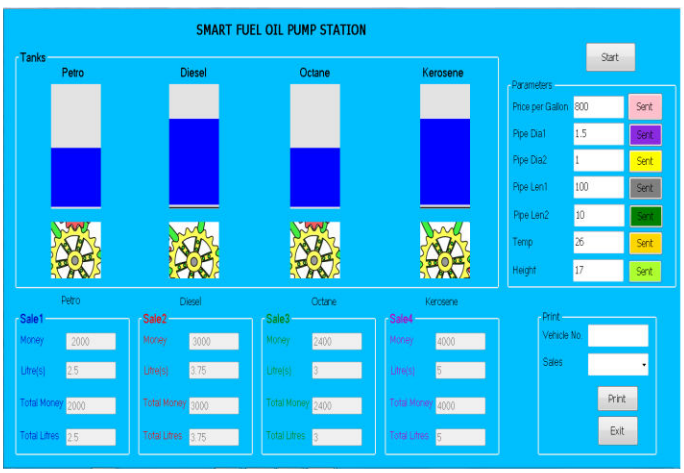


Figure 4. Result of the system

For solving unexpected problems for dealers, the "Print" function is considered in this system. Firstly, the vehicle No and sales must be selected to print the bills. For octane and sale 3, the print result is shown in Fig.5 and Fig.6.

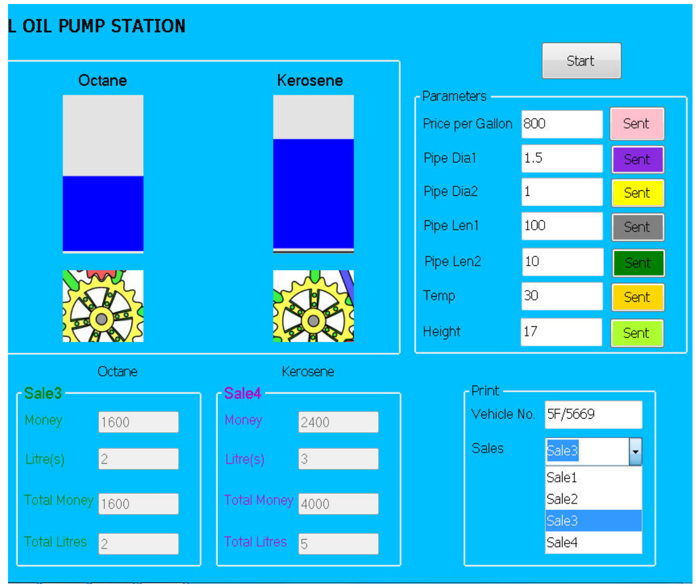
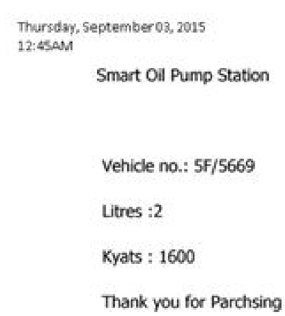


Figure 5. Selecting of counter functions

Figure 6. VB.Net simulation "Print" function



After the amount money had been pressed on the keypad, the pump motors will drive to pump the fuel. This amount is decreased to zero according to the time taken.

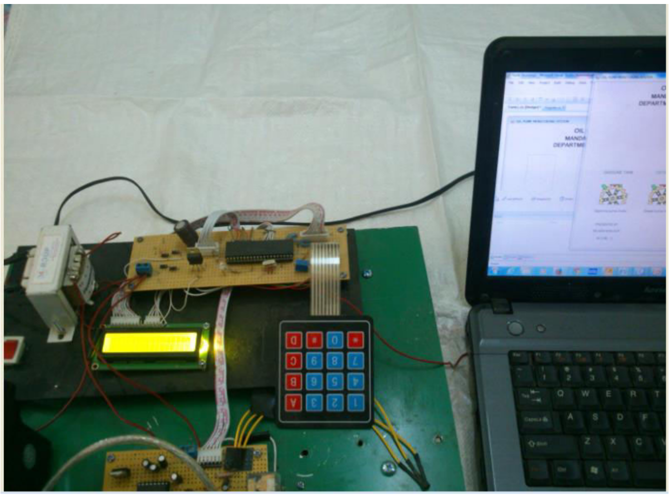


Figure7. Control Circuit of the System

V. CONCLUSION

The system is flexible both customers and dealers compared to other dispensing units which use the sensor for measuring the oil flow and the system is economy because the system depends on the software. It can be used to dispense any of the fluids (like water, oil, vegetable oil, workshop greases etc...).This system will be more convenience and safety for the customers. But I think the system will change the data depending on the pipe diameter used in the stations.

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