Available online www.jsaer.com

***Journal of Scientific and Engineering Research*, 2019, 6(10):39-43**

Research Article

ISSN: 2394-2630
CODEN(USA): JSERBR

Distant Control of Fluid Level in a Sealed Container

Anna Antonyová[1]*, Peter Antony[2]

[1]Department of Mathematical Methods and Managerial Informatics, Faculty of Management, University of Prešov in Prešov, Slovak Republic
[2]APmikro, Prešov, Slovak Republic
*Corresponding author: antonyova@gmail.com

Abstract Sometimes during the production process or in some manipulation with chemicals happens that the fluid is in a sealed container and the fluid level should be controlled. If the container is placed directly in the production hall or the container comprise the special chemicals which requires distant control, the results describing the measurement the fluid level might be transferred via internet or local net connection. The article is based on the scientific research that copes with those two problems: measurement of the fluid level in the sealed container and its distance control. Statistical method of correlation is used to proof the experimental results.

Keywords control, fluid level, linearity, statistics

Introduction

Scientific research is often aimed to interfaces of different materials [1] as well as the flow of fans [2] or fluid. Materials such as fluid is under investigation for various reasons, for example medicine [3]. The correlations were set as a method for modelling the relationships between the thermal properties and nano-fluid characteristics of distilled water, ethylene glycol and their mutual mixture [4].

The properties of fluid on surface water level as it influences the vapor creation [5] can be expressed through the method of mathematical modelling for instance using the differential equations. Dynamics and heat transfer on horizontal fluid surface is associated also with the bubble creation during boiling process [6]. Time-dependent initial-value partial-differential equation is also used to represent fluid-interface problems [7].

Canonical fluid model describes some risk processes [8] as well as complex probability models. One of the risk processes is also seismic response of liquid storage tanks [9]. Numerical models describe not only liquid-structure interface but also stress, strain and strain distributions throughout the tank.

Our research copes with two problems:

- Measurement the fluid level;
- Distant control of the fluid level in a sealed container.

Methodology

The closed 12liter stainless steel pressure container (Figure 1) is used for controlled fluid for precise spraying to reduce material stress at the bend. In practice, the fluid pressure is in the range of 3 to 4 atm, depending on the amount required.

Of course, the amount of fluid consumption to specify the bend location depends on the length of the subsequent bend of corrugated paper and the amount of production. It can be, for example, 20 liters per shift or 6 liters per shift. However, the container is usually filled 1 time per shift.

Figure 1: Container where fluid level is measured

Thus, the container is filled with the fluid once during the working change. The container is then sealed, and the fluid can be dispensed in a controlled manner at selected sites.

The fluid level is measured at intervals of one second, but evaluation in a TCP/IP network is enough, for example, once every quarter hour. In this way, the network data load is almost zero. Therefore, many sensors can be connected to the network without interference. Sensor to control the fluid level is expressed in Figure 2.

Figure 3 expresses graphical representation of the equipment in the container; where W is a wire which is embedded in electrically insulating material (I). Container is marked as V (vessel) and f represents the fluid level.

Figure 2: Sensor to control the fluid level with signalization

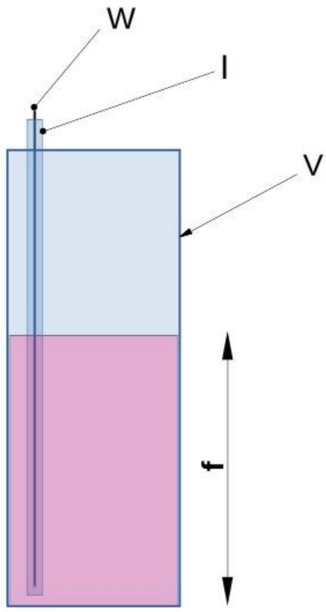

Figure 3: Graphical representation of the equipment in the container where the fluid level is measured

Scheme (Figure 4) - capacitance measurement has accurate stable + 5V supply on input 1. Input 2 is Ground (GND - reference point for all signals or common path in electrical circuit where all the voltages can be measured from); the frequency is measured at output 3 and the measured capacity is connected to input 4.

The frequency is decreasing. The larger the capacitance value, the lower the frequency of the NE555 circuit being used. At zero capacitance, the frequency is highest, corresponding to the parasitic value (wires, internal structure of the NE555 integrated circuit). In this case, the frequency is 36996 Hz, which corresponds to a parasitic capacity of 27.029pF (= 1/36996). This value is then subtracted from the measured value of the capacitor that is connected to input 4 (between GND and pin 2 on the NE555).

Perform 1 divided with measured number, the result is in microfarads (μF), from which we subtract the parasitic 27,029pF.

The signal at the output 3 of the NE555 integrated circuit is further digitally modified so that it can be further transmitted via the wiring on the TCP / IP system board.

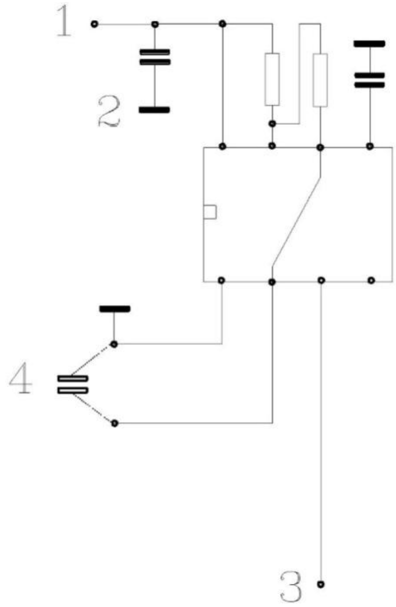

Figure 4: Schematic representation of capacitance measurement

It is necessary to control the amount of fluid in the pressure container. This is done by a capacitive sensor that provides a digital signal, which is then transmitted to the internal Internet part of the network. From time to time, it is possible to accurately determine the momentary standstill (a few minutes) of the machine to replenish a 12liter container with fluid. The container with the connection is expressed in Figure 5.

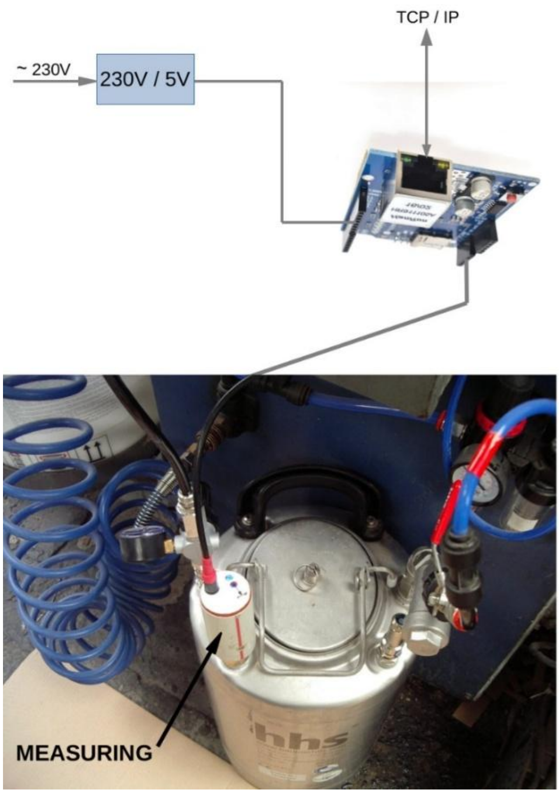

Figure 5: Scheme how the system of the fluid level control is managed

Results and Discussion

The results regarding the fluid level in a sealed container were already obtained experimentally. To proof the results the statistical method of correlation with the trend line expression was used. If the trend line has shape of the linear dependency with sufficient values of parameters, the measurement method indicates the real results regarding the level of the fluid in the container.

Firstly, the value of the Pearson coefficient *r* was computed according to (1):

$$r = r_{xy} = \frac{\sum x_i y_i - n\bar{x}\bar{y}}{\sqrt{(\sum x_i^2 - n\bar{x}^2)(\sum y_i^2 - n\bar{y}^2)}} \quad (1)$$

$n = 12$

$r = 0.999773709$

$r^2 = 0.9995$

The results were compared on the level α.

$\alpha = 0.05$

If the left side of (2) is more than the value of quantile *t*, than the liquid level correlates with the capacitance results and trend line means the linear dependency (Figure 6).

$$\frac{|r|\sqrt{n-2}}{\sqrt{1-r^2}} > t_{1-\frac{\alpha}{2}}(n-2) \quad (2)$$

$148.6202013 > t_{0.975}(10)$

$148.6202013 > 2.228$

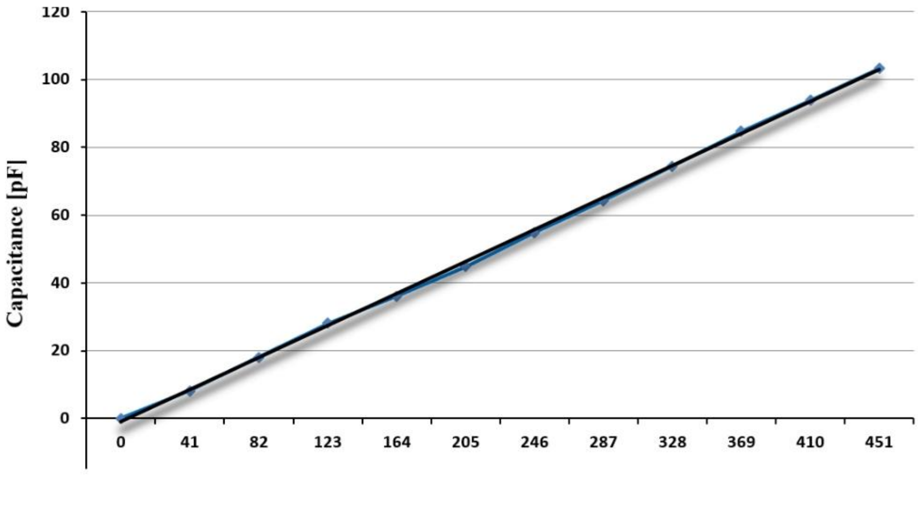

Figure 6: Graphic characteristics the results of capacitance [pF] in correlation to fluid level [mm] with the trend line expressing the linear dependency

The dependency that is expressed in Figure 6 can be expressed using the (4) as the result of the system of equations (3)

$$a_0 n + a_1 \sum_{i=1}^{n} x_i = \sum_{i=1}^{n} y_i$$

$$a_0 \sum_{i=1}^{n} x_i + a_1 \sum_{i=1}^{n} x_i^2 = \sum_{i=1}^{n} (x_i y_i) \quad (3)$$

$$y = a_0 + a_1 x \quad (4)$$

$$y = 9.4382x - 10.447 \quad (5)$$

The result of the expressed linear dependency is expressed in (5). This way also the rightness of the used methods was proved.

Conclusions

The article deals with the problem of control the fluid level in sealed container. The method is based on measurement the capacitance and the results are transferred via internet. The method was realized also experimentally, and the results were proved using the statistical method when the results show correlation between fluid level and capacitance values. In the future we aim to research in connection with capacitance values.

Acknowledgement

The research was conducted as a part of the international scientific project 4596-6-17/19 supported by the University of Prešov in Prešov "Modeling of environmental management processes".

References

[1]. Olsson, E., & Kreiss, G. (2005). A conservative level set method for two phase flow. *Journal of Computational Physics*, 210(1):225-246.
[2]. Al-Asmi, K., & Castro, I. P. (1993). Production of oscillatory flow in wind tunnels. *Experiments in Fluids*, 15(1):33-41.
[3]. Hao, D., Li, M., Wu, Z., Duan, Y., Li, D., &Qiu, G. (2011). Synovial fluid level of adiponectin correlated with levels of aggrecan degradation markers in osteoarthritis. *Rheumatology international*, 31(11):1433-1437.
[4]. Xu, J., Bandyopadhyay, K., & Jung, D. (2016). Experimental investigation on the correlation between nano-fluid characteristics and thermal properties of Al_2O_3nano-particles dispersed in ethylene glycol-water mixture. *International Journal of Heat and Mass Transfer*, 94:262-268.
[5]. Sussman, M. (2003). A second order coupled level set and volume-of-fluid method for computing growth and collapse of vapor bubbles. *Journal of Computational Physics*, 187:110-136.
[6]. Son, G., Dhir, V. K., & Ramanujapu, N. (1999). Dynamics and heat transfer associated with a single bubble during nucleate boiling on a horizontal surface. *Journal of Heat Transfer*, 121(3):623-631.
[7]. Sethian, J. A., & Smereka, P. (2003). Level set methods for fluid interfaces. *Annual Review of Fluid Mechanics*, 35:341-72.
[8]. Ramaswami, V. (2006). Passage Times in Fluid Models with Application to Risk Processes. *Methodology and Computing in Applied Probability*, 8(4):497-515.
[9]. Ozdemir, Z., Souli, M., & Fahjan, Y. M. (2010). Application of nonlinear fluid-structure interaction methods to seismic analysis of anchored and unanchored tanks. *Engineering Structures*, 32(2):409-423.