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Semi – Automation Design Using Flow Injection Analysis System with Smart Phone for the Determination of Total Phenols in Wastewater

Hakeem Jabbar Ilaybi*, Mustafa Abdulkadhim Hussien

Department of Chemistry, Faculty of Science, Kufa University – Iraq

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ABSTRACT

Smart phone used as supporting hardware in different applications in chemical analysis is becoming increasingly important in everyday life. Rapid, easy, and straightforward analytical system flow injection analysis system for the determination of the total phenols was conducted using 4-aminoantipyrine reagent. The detection method was based on the reaction total phenols with reagent in the basic media and subsequent formation of a yellow color product. The samples or standard solutions were injection into a carrier stream to react with 4-aminoantipyrine reagent and ammonium chloride with ammonium hydroxide to give yellow color product, which was detected by spectrophotometer at 510 nm. The experimental condition such as flow rate of reagent and carrier, reagent volume, length of reaction coil and concentration of reagent were optimized. A good linear calibration curve in the range of 250-2000 mg L^{-1} was obtained with regression equation (y=0.0108 x + 0.3453), (R= 0.9989). The limit of detection was in the amount of 0.0112 mg L^{-1}. The method was successfully applied for the determination of the total phenols in wastewater.

1. Introduction

Due to its simplicity, convenience of installation, and straightforward analytical system, flow injection analysis is the most common and widely used . It is also flexible in that it allows for customization and invention and has a wide range of applications (Ruiz-Capillas & Jimenez-Colmenero, 2008; de Castro, & Valcárcel, 1989). The most important characteristics of flow injection analysis are can analyze multiple samples, a very fast response time ,small sample size injection , high accuracy (Leamsomrong, Suttajit, & Chantiratikul, 2009). A liquid sample must be injected into a carrier solution that is moving in a continuous to the detector that records continuously the changes in absorbance (Fang, Růžička, & Hansen, 1984; Worsfold, et al., 2019). Low consumption of sample and reagents, the partial and reproducible development of the involved steps other properties inherent to flow analysis (Rocha, et al., 2002). Smart phones are sophisticated cell phones with operating systems that are able to handle complex computing operations, such as downloading and using mobile phone applications, online browsing, and email. In order to benefit from smart phone' portability, connectivity, ease of use, and ubiquitous s connectivity, there has been a growing trend in industry and academia to develop sensors that integrate with smart phones (Daponte, et al., 2014). Smart phones are the most convenient option for processing, sharing, and transportation of data and photographs.

They are also easily portable, widely available, user-friendly, and inexpensive devices. In addition, analysis can be done anywhere thanks to Bluetooth and Internet connectivity (Salman & Hussein, 2021). New smart phone-based techniques offer promising means of (F- ion) detection (Pelegris, et al., 2010), determination iron (II) in a pharmaceutical formulation (Hussien & Kadhim, 2022), environmental sensors (Thio & Park, 2022), in addition to detecting enzymatic urea hydrolysis in micro fluidic system (Salman & Hussein, 2021) and spectral iron detection (Fatima, 2022). Phenol an aromatic organic molecule, derivatives of phenol abundant in the environment, these

***Corresponding author:** Hakeem Jabbar Ilaybi, Chemistry Department, Faculty of Science, Kufa University – Iraq

E-mail: **hakeem.alkareemawi@uokufa.edu.iq**

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compounds are employed in the manufacture of dyes, polymers, medicines, and other organic molecules (Fadhil, 2017). In the study, a new method included total phenols determination in wastewater by Semi – automation design using flow injection analysis system with smart phone**.**

2. Materials and Methods

2.1. Chemicals

All solutions needed in the determination of total phenols by the 4-aminoantipyrine method include :

2.1.1. Phenol Solution

A stock solution of phenol was prepared by dissolving 2.00 g of phenol in a small amount of boiled and cooled distilled water and diluted to a liter. Each milliliter of this solution contains one milligram of phenol.

2.1.2. 4- Amino Antipyrine Reagent

Dissolve (2 g) of 4- amino antipyrine in a small amount of distilled water and dilute it to (100 ml). This solution is suitable for use for one day

2.1.3. Potassium ferricyanide solution

Dissolve (8 g) of Potassium ferricyanide solution in a small amoun of distillad water, dilute it to (100 ml) and then filter.This solution is suitable for use for one week only.

2.1.4. Ammonium chloride solution

Dissolve (50 g) of Ammonium chloride in a small amount of distilled water and dilute it to a liter .

2.2. Equipment

2.2.1. UV-Visible Spectrophotometer, EMC-11UV, Emclab, Germany, (single Beam)

2.2.2. Electric balance, Bp301S, Sartorius, Germany

2.2.3. smart phone device (Galaxy A30s). India

2.3. Flow Injection Analysis System

The standard solution or reagent were pumped for channel via a peristaltic pump to injection valve and were injected into a carrier stream, the sample was reacted with the reagent via reaction coil then to flow cell of the spectrophotometer at 510 nm, the signal was measured by smart phone via SR program. Show (Figure 1) using smart phone with FIA instrument.

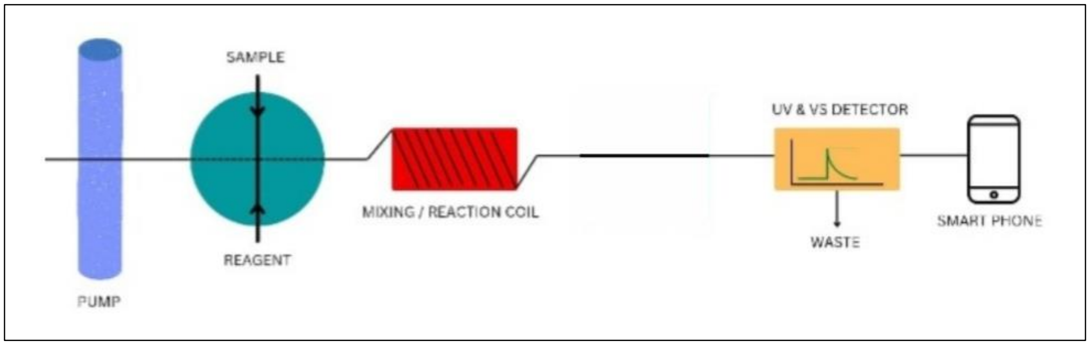

Fig. 1. Semi – automation design using flow injection analysis system with smart phone

2.4. Methods Used In the Measurement

A volume of 100 ml standard phenol solution with concentration 2000 ppm. Prepared 2 ml of ammonium chloride solution and then equalized to pH (10) by adding ammonium hydroxide , then added to it 2 ml of amino antipyrine solution and mix well , and 2 ml of ferric potassium cyanide, mix again. A spectrophotometer is used to quantify the light absorption at a wavelength of 510 nm (Dannis, 1951).

3. Results and Discussion

The effect of flow rate was studied on (Phenol and reagent) solutions by changing the flow rate with a range (1-5) ml/min. The results showed that the optimum flow rate was (4ml/min) , then the peak height decrease because of low measurement sensitivity in high speed due to the lack of time for the components to remain in the measurement cell and the increased mitigation which is increasing with increasing speed, (Figure 2a) .

For the purpose of studying the effect of the reaction coil length at the peak height different lengths were used of the reaction coil length ranged from (25-150) cm, the results indicated that the optimal length was (100 cm). It was obtained at this length on the best peak height, then the height was lower as a result of an increased dilution, accompanying increased coil length, (Figure 2b)

Concentration was studied on the process of phenol .It was between ($10×10^3$- $50×10^3$) ppm .The results indicated that the optimal concentration was ($30×10^3$ ppm) , this is due to the good mixing between phenol mix and (4-aminoantipyrine) , after this concentration the peak height was decreased due to low measurement sensitivity, (Figure 2c) .

The effect of volume of 4-aminoantipyrine reagent. Prepared different volumes were of solution .It was between (0.1-0.5) ml .The volume was (0.2ml) giving the best peak height an increase in volume reduces the peak height, due to the increased dilution of converging areas when they reach the detector, (Figure 2d).

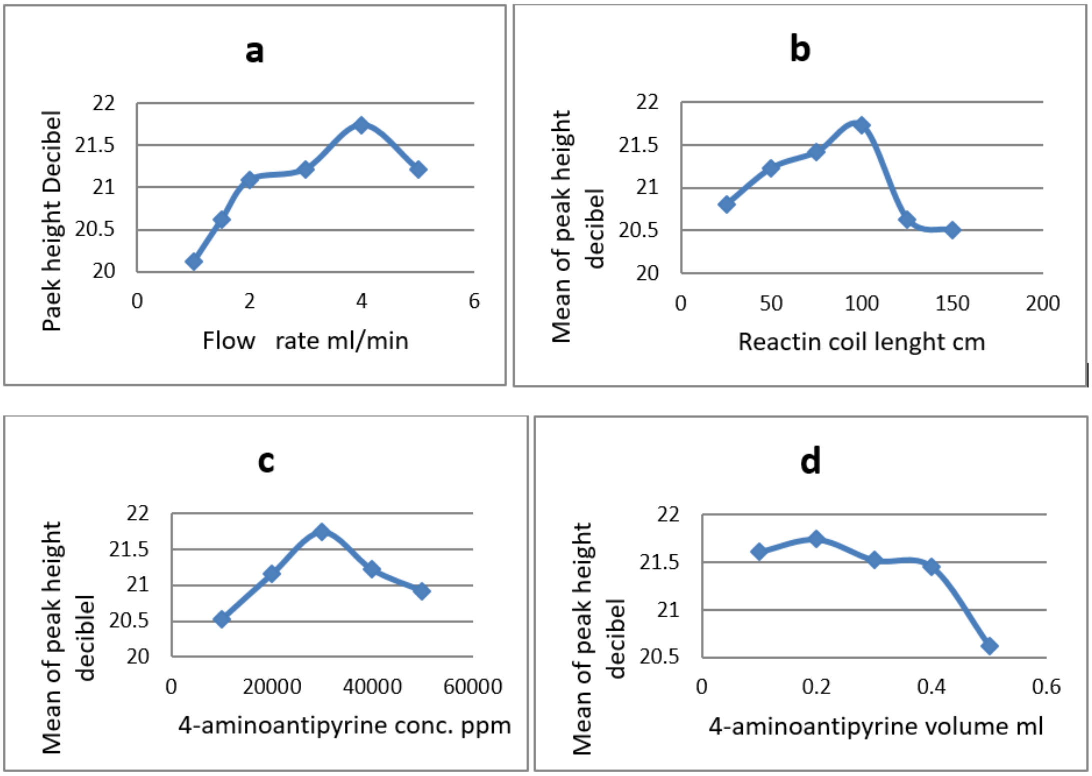

Fig. 2. The Factors Affecting the Flow Injection System and choosing the Optimal Conditions

3.1. Repeatability of FIA Unit Using 4-aminoantipyrine reagent

To study the precision and accuracy of the design system, repeatability of FIA. Unit using 4-aminoantipyrine reagent with (500 mg/L) of standard phenol solution, the relative standard deviation for 10-time show in Figure (3)

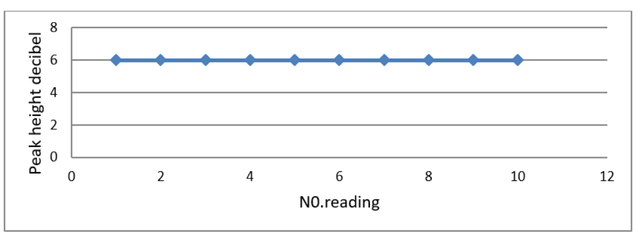

Fig. 3. Repeatability of FIA Unit Using 4-aminoantipyrine reagent

3.2. The Calibration Curve

Series of concentrations of phenol was prepared .The curve was between (25-3000) ppm ,the study showed that the linearity of the results ranged from (250-2000) ppm , then there was a negative deviation, and the detection limit was 0.0112 mg / L^{-1} (3 readings of blank) , (Figure 4 and Figure 5).

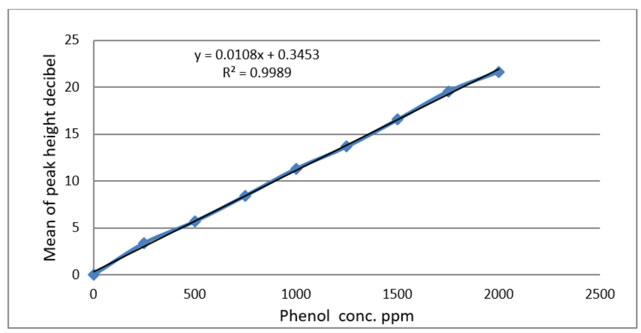

Fig. 4. Calibration curve in FIA method using 4- aminoantipyrine reagent

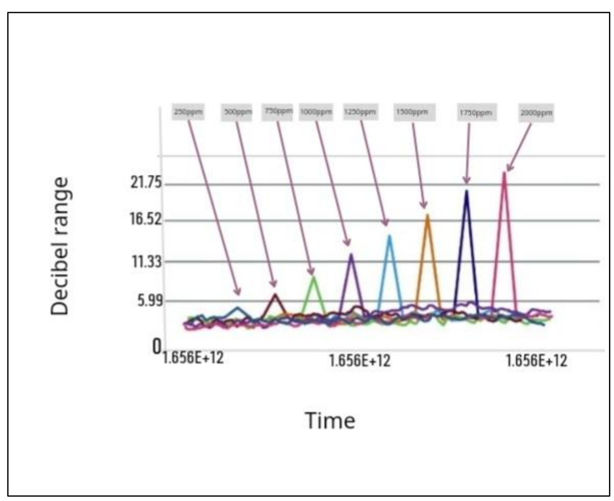

Fig. 5. The change in phenols concentration of a FIA system with smart phone

3.3. Analytical of Wastewater Samples

Using phenol as a benchmark, the approach was used to identify phenols in two wastewater samples provided by an environmental monitoring station. The samples were injected into the Flow injection system without any prior preparation after being diluted with 0.05 mol L^{-1} H_2SO_4 to fit within the calibration plot. Because more phenols were found and the response factors in the suggested technique were greater than for the traditional method (spectrophotometer), the results were marginally better than those obtained using the traditional method (spectrophotometer). Recoveries obtained the results of the examination of standard solutions of phenol by the traditional method and the new method are listed in Table 1.

Table 1
The results of the examination of standard solutions of phenol by the traditional method and the new method.

Analytical samples mg/L	Traditional method mg/L	RSD% Traditional method	Recovery % Traditional method	The new method mg/L	RSD% the new method	Recovery% The new method
250	243	1.088	97.2	245	0.623	98
500	492	0.732	98.4	494	0.535	98.8

3.4. Application of the Proposed Method to Real Samples

The total phenolic compounds in wast water, river water were determined using the suggested approach. With a correlation coefficient of 0.9989, the proposed standard approach was determined to have good agreement.

4. Conclusion

For the purpose of determining the total phenolic chemicals in wastewater, a sample rapid and reliable flow injection analysis system using a smartphone was developed in the study. The proposed of method detection limit was 0.0112 ppm.

Competing Interests

The authors have declared that no competing interests exist.

References

Dannis, M. (1951). Determination of phenols by the amino-antipyrine method. Sewage and Industrial wastes, 1516-1522. **https://www.jstor.org/stable/25031773**

Daponte, P., De Vito, L., Picariello, F., & Riccio, M. (2014). State of the art and future developments of the Augmented Reality for measurement applications. Measurement, 57, 53-70. **https://doi.org/10.1016/j.measurement.2014.07.009**

de Castro, M. L., & Valcárcel, M. (1989). Flow injection analysis of pharmaceuticals. Journal of Pharmaceutical and Biomedical Analysis, 7(12), 1291-1300. **https://doi.org/10.1016/0731-7085(89)80135-9**

Fadhil, G. (2017). Flow Injection Spectrophotometric Determination of Baclofen in Pharmaceutical Formulation Using Prussian Blue Reaction. Al-Nahrain Journal of Science, 20(1), 17-24. **https://mail.anjs.edu.iq/index.php/anjs/article/view/33/17**

Fang, Z., Růžička, J., & Hansen, E. H. (1984). An efficient flow-injection system with on-line ion-exchange preconcentration for the determination of trace amounts of heavy metals by atomic absorption spectrometry. Analytica chimica acta, 164, 23-39. **https://doi.org/10.1016/S0003-2670(00)85614-7**

Fatima. A. Kadhim, Mustafa A. Hussein. (2022). Construction of a homemade microfluidic sensor system for spectroscopic iron determination using a mobile phone as a detector, NeuroQuantology, 20(11), 3797-3806. **https://www.neuroquantology.com/article.php?id=7939**

Hussien, M. A., & Kadhim, H. H. (2022). Novel Semi-Automated Design for Determination of Iron in Water using Smartphone Camera Complementary Metal-Oxide-Semiconductor (CMOS) Biosensor as a Detector Device. Biomedicine and Chemical Sciences, 1(4), 270-277. **https://doi.org/10.48112/bcs.v1i4.284**

Leamsomrong, K., Suttajit, M., & Chantiratikul, P. (2009). Flow injection analysis system for the determination of total phenolic compounds by using Folin-Ciocalteu assay. Asian Journal of Applied Sciences, 2(2), 184-190. **https://www.cabdirect.org/cabdirect/abstract/20093157022**

Pelegris, P., Banitsas, K., Orbach, T., & Marias, K. (2010, August). A novel method to detect heart beat rate using a mobile phone. In 2010 annual international conference of the IEEE engineering in medicine and biology (pp. 5488-5491). IEEE. **https://doi.org/10.1109/IEMBS.2010.5626580**

Rocha, F. R., Reis, B. F., Zagatto, E. A., Lima, J. L., Lapa, R. A., & Santos, J. L. (2002). Multicommutation in flow analysis: concepts, applications and trends. Analytica Chimica Acta, 468(1), 119-131. **https://doi.org/10.1016/S0003-2670(02)00628-1**

Ruiz-Capillas, C., & Jimenez-Colmenero, F. (2008). Determination of preservatives in meat products by flow injection analysis (FIA). Food Additives and Contaminants, 25(10), 1167-1178. **https://doi.org/10.1080/02652030802036214**

Salman, Z. J., & Hussein, M. A. (2021). Utilize smartphone as a novel detector for enzymatic urea hydrolysis in microfluidic system. Preprints 2021, **https://www.preprints.org/manuscript/202102.0497/v1**

Thio, S. K., & Park, S. Y. (2022). A review of optoelectrowetting (OEW): from fundamentals to lab-on-a-smartphone (LOS) applications to environmental sensors. Lab on a Chip. **https://doi.org/10.1039/D2LC00372D**

Worsfold, P., Townshend, A., Poole, C. F., & Miró, M. (2019). Encyclopedia of analytical science. Elsevier.