PORTABLE WATER FLOW NETWORK SYSTEM FOR CONTAMINATED WATER DETECTION USING SIMPLE MATHEMATICAL FORMULATION

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ABSTRACT: A real-time monitoring of heavy metals in water environment is crucial nowadays because it is the biggest contributor to water pollution and leads to many diseases to humans. In contrast with organic pollutants, heavy metals cannot be biologically or chemically degraded at all, and thus may either accumulate locally or be transported over long distances. The wastewater discharge from Batik industries became a significant issue on the sustainability of the environment for the next generation. This study proposes the development of instrument device to real-time monitoring heavy metal using an electroanalytical technique. This project introduced mathematical algorithm to represent the existing metal concentration in the solution based on statistical analysis from the data collection using laboratory control sample. In order to ensure the result more robust, the others significant parameter such as temperature and pH were considered during mathematical formulation development. For field work application, the effect of viscosity, pressure drop and condition of pipe for steady flow. The flow changes affect the measurement sensor reading due to the turbulent flow. However, the flow change inside pipe network can change the physical disturbance that can lead to inaccuracy of data measurement.

KEYWORDS: *Laboratory Control Sample. Steady Flow, Flow Change, pH and Pipe Network*

1.0 INTRODUCTION

Malaysian batik is the local craft with the process of drawing fine lines or dots of wax on the surface of fabrics to stimulate its design to avoid absorbing colours during the dyeing process (Akhir and Ismail, 2015). Commonly, batik industry brings out the uniqueness with variety of colours and design that makes it to be an identity to Malaysia and recognize by local people. Furthermore, United Educational, Scientific and Cultural Organization (UNESCO) has recognized batik craft as a living cultural heritage which relates to the traditions inherited form ancestors to the future generations which creates a better opportunity to globalize the Malaysia's batik industry (Akhir et al., 2018).

As the country's eleventh largest exporter, the textile industry has contributed approximately RM15.3 billion which is 16% of the Malaysia's total export of goods in 2017 making USA the leading importer of Malaysia's textile products with RM2.2 billion(14.6%) followed by Japan and Turkey (MIDA, 2019).
The process of making batik is the art of the workmanship making designs on a piece of fabric. The process starts with using melted wax painted or stamped onto a white or a coloured fabric before being dyed because the waxed areas are inaccessible by the dye (WIDIHASTUTI, 2014). Next the stamped

fabric undergoes bleaching process to remove the remove the unwaxed regions colour leaving the design of the waxed region. The bleached fabric is then dyed again on the other part of the fabric without wax before smoked to obtain a nuanced background. Finally, the fabric is boiled to remove the wax to get a magnificent result. The major problem that caused by the batik industry is discharge of wastewater during soaking, boiling and rinsing without proper treatment procedure. The waste discharged are in large amounts with high concentration of pollutants such as heavy metals requires an extra attention on the treatment part before releasing to the environment because the waste discharged to the nearby rivers can cause the underwater aquatic life to be affected (Subki and Rohasliney, 2011).

2.0 METHODOLOGY

The methodology starts with literature review case study that relates to heavy metal monitoring to increase the knowledge and potential on the development of heavy metal monitoring system for wastewater discharge in industries. The literature review study helps to know better the previous research that have been done with different techniques of monitoring system and gives a better view before executing this project. Next, the development of algorithm was done by using the electroanalytical method for monitoring heavy metal based on the significant parameters which are needed to detect the heavy metal waste in water such as the electrical conductivity (EC), temperature and the pH value of the solution. During the data collection, series of solution were prepared using synthetic solution. Apart from that, apparatus set up was done with water pump connected with pipe networks and sensors that replicates the real wastewater discharge unit that monitors the heavy metal discharge in a laboratory scale. The calibration process was done to the sensors next in order to obtain a reliable data that supports during result and discussion in Chapter 4. In the last phase, the obtained data were analysed and validate before plotting the graphs.

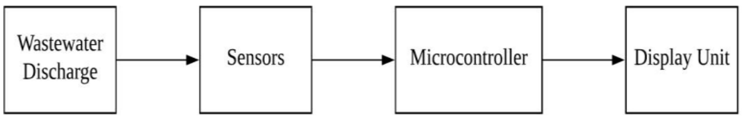


Figure 1: Block diagram of heavy metal monitoring system

The figure 1 depicts the of the heavy metal monitoring system that has been used in this project. Firstly, the wastewater discharge from the endpoint of the pipe network is monitored by sensors which reads the ion content in the wastewater through the potential voltage measured by the sensors through its electrodes. The main responsibility of the sensors is to send the potential voltage and current in the form of electric current to the microcontroller which is the Arduino UNO. The Arduino then receives the signal of current in the form of computer language and the microprocessor converts binary language to human language before displaying the output on the computer screen. The voltage difference between two electrodes are measured compatible with the amount of ion concentration in the solution and the voltage also refers to the resistance in the solution. Since the conductance is the reciprocal of resistance, the measurement of current and potential voltage is depicted in below;
The transfer function of the measurement circuit is;

$$\boldsymbol{Voutput} = \boldsymbol{R10}(\boldsymbol{820\Omega})/\boldsymbol{Rsolution} \times |\boldsymbol{Vinput}| \quad (1)$$

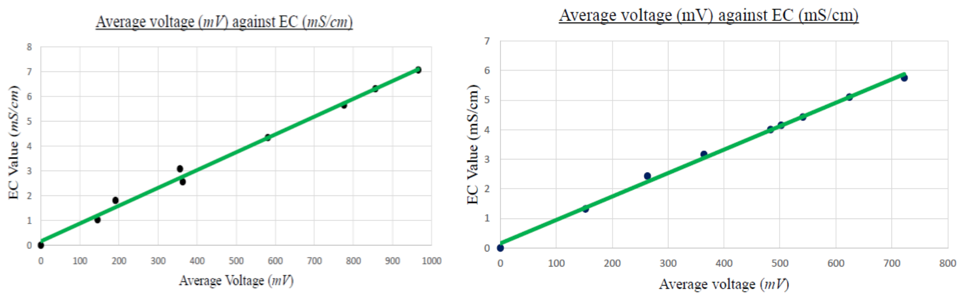
where, $Rsolution$ is the measurement of resistance in the solution which can be obtained from the equation below;

$$\boldsymbol{Rsolution} = \boldsymbol{\rho L A} \quad (2)$$

3.0 RESULTS AND DISCUSSION

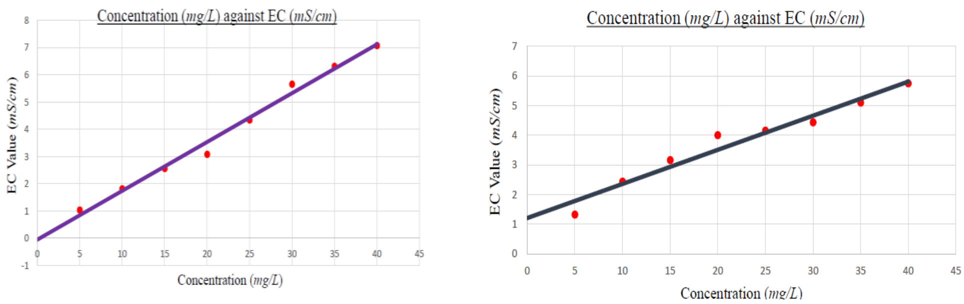
3.1 Static Experiment

The static experiment was done where the sensors were placed in a beaker containing the heavy metal contamination and the output voltage, EC value and the temperature readings were shown on the computer screen. The static experiment of measuring the heavy metal content in the solution was done in order to make comparison with the dynamic experiment data reading. The static experiment is where there is no fluid flow involved during the experiment. The experiment was done for Copper (Cu) and Lead (Pb) and the data are plotted below. Figure 2 represents the Average Voltage against EC and in Figure 3 shows the changes when concentration change, both graph agreed linearity features. In Figure 4, shows performance of temperature against EC value. The curvature line has been plotted.



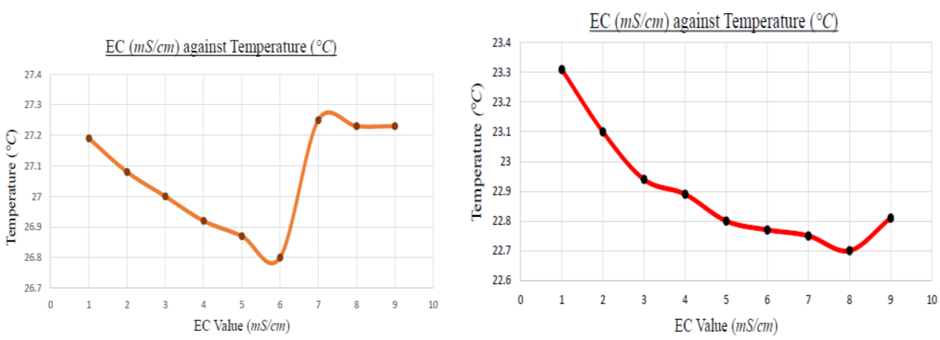
(a) (b)

Figure 2: Graph of average voltage (mV) against EC (mS/cm) for (a) Cu (b)Lead



(a) (b)

Figure 3: Graph of Concentration (mg/L) against EC (mS/cm) for (a) Cu (b)Lead



(a) (b)

Figure 4 : Graph of EC (mS/cm) against Temperature (°C) for (a) Cu (b)Lead

4.0 CONCLUSION

The heavy metal contents in wastewater are very dangerous when the wastewater is directly released to the environment through the nearby water banks and the physical precipitate will accumulate in the sediments on the water environment.

The wastewater effluent will cause the aquatic life is harmed through chemical adsorption process which later can enter human body and affects human health after they consume the underwater organisms. The wastewater from the batik industry during the soaking, boiling and rinsing process are the main contributors of heavy metal effluents from the textile industry because these processes discharge large amount of high concentration of pollutants and discharged without proper treatment procedure. In general, all the objectives of this project are met and achieved. The analytical method to monitor the heavy metal content was modelled in a laboratory scale with data developing system, mathematical formulation, fundamental of the sensors and the characteristics of heavy metals studied from the literature survey. Therefore, first objective is to set up a sub scale heavy metal monitoring instrument in a laboratory scale is achieved. The previous model had was too bulky and this project is to reduce the scale to make it portable.

3.0 REFERENCES

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