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Determination of Potassium Concentration in Solution Using Optical Fiber Sensors

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Abstract. Potassium is a mineral that has an important role in maintaining fluid balance in the human body and controlling blood pressure in the body. In addition, potassium also plays a role in maintaining the function of the muscles and nerves that control the heart. The development of instruments and methods developed to obtain more accurate measurements of potassium concentration requires an instrument with high sensitivity. One of the instruments utilizes the principle of electromagnetic wave symptoms made by optical sensor systems with the use of optical fibers for waveguides to maintain their intensity stability. The optical fiber bundle instrument in the optical sensor system to determine potassium concentration in the hope that this instrument can present accurate measurement parameters and better sensor sensitivity. In this study, samples of standard solutions with potassium as a solute and pure water function as solvents. Potassium solution samples that are in the bottom of the vessel there is a flat mirror that reflects the laser beam that has been through the process of absorption by the sample solution. The reflected neon helium laser is transmitted through the optical fiber receiver to measure the change in wave intensity using an optical detector. The intensity of the reflected laser beam waves is read by an optical detector and converted to an electrical energy display by measuring the maximum electrical voltage using a digital voltmeter. The parameters measured in the experiment investigate the relationship between the change in the concentration of the potassium solution and the maximum voltage read on a digital voltmeter. The results of data analysis determine the concentration of potassium to achieve high sensitivity, linearity and accuracy with a sensitivity value of 0.01 mV/ppm, linearity of more than 99%, linear range of 0-10 ppm, so the instrument is very valid and high sensitivity.

1. Introduction

Potassium is a mineral that has an important role in maintaining fluid balance in the human body and controlling blood pressure in the body. In addition, potassium also plays a role in maintaining the function of the muscles and nerves that control the heart. Potassium is an important mineral known as electrolytes. Body conditions that are deficient in potassium can be the body will give a sign through a series of symptoms. The symptoms are mild and severe depending on how badly the body loses potassium. Under normal conditions, potassium levels in the blood range from 3.5 to 5 mEq / L. If the level of potassium in the blood is less than 3.5 mEq/L, the body condition is not normal and potassium deficiency. To make sure the potassium levels in your body are at normal limits or spot, you can consult a doctor. Usually the doctor will recommend patients to do some laboratory tests such as blood



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tests and urine tests. There are several conditions that can cause a person to lack potassium. For example, a person experiences vomiting and diarrhea simultaneously, sweating too much, alcoholism, eating disorders such as bulimia, and excessive use of laxatives. In addition, potassium deficiency can also be caused by the effects of serious medical conditions, such as chronic kidney failure, diabetes ketoacidosis, folic acid deficiency, and malnutrition.

Potassium deficiency can be prevented by consuming foods that contain high potassium. Potassium-containing foods are not difficult to find and can be included in the daily diet. Some foods that contain high potassium that you can consume daily to prevent potassium deficiency such as bananas, potatoes, and avocados. Knowledge of normal body conditions by observing the condition of the concentration of potassium in the body needs instruments and methods including the determination of potassium with invasive in plants [1]. The development of instruments and methods developed to obtain more accurate measurements of potassium concentration requires an institution with high sensitivity. One of the instruments utilizes the principle of electromagnetic wave symptoms made by optical sensor systems with the use of optical fibers for waveguides to maintain their intensity stability.

Optical fiber is an electromagnetic wave transmission channel that uses very fine glass and plastic materials to transmit light waves. Light sources often use laser beams like Laser Helium Neon. Optical fibers such as this type of bundle are approximately 120 micrometers in diameter. Light in the optical fiber does not come out because the refractive index of the glass is greater than the refractive index of the air, because the laser has a very narrow spectrum.

The use of optical sensors with fiber through the principle of optical fiber shift is often used to detect solution concentrations. Detection of concentrations using optical fiber shift sensors is often done to determine the concentration of the solution by various methods such as bundle optical fibers, taper optical fibers, and optical fiber couplers.

Applied optical sensor research on various types of optical fibers continues to grow, this is evidenced by the many articles about the use of optical fibers in sensors published in international journals. Intensity based optical fiber sensor for calcium detection [2]. Optical sensor for the detection of honey purity in distilled water [3]. Multimode design of taper fiber sensors for glucose detection [4]. Optical fiber sensor detection of NaCl salt with a flat mirror and concave mirror [5]. The bundle optical fiber shift sensor uses the Quasi-Gaussian beam approach. Researchers to conduct research to determine the concentration of potassium in a solution using optical fiber bundles made optical sensor systems.

Based on the background description and the problems above, the researcher tries to develop a fiber optic bundle instrument in an optical sensor system to determine the potassium concentration in the hope that this instrument can present accurate measurement parameters and better sensor sensitivity.

2. Method

This research was conducted using the experimental method. Technical in determining the concentration of potassium in a solution with the principle of electromagnetic wave absorption where the neon helium laser is the source of the waves. Fluorescent helium laser beams are guided by optical fibers to maximize the intensity of the source that is the sample solution through the optical fiber receiver. The sample solution used in this study was a sample of standard solution with potassium as a solute and purified water functioning as a solvent. Potassium solution samples that are in the bottom of the vessel there is a flat mirror that reflects the laser beam that has been through the process of absorption by the sample solution. The reflected neon helium laser is transmitted through the optical fiber receiver to measure the change in wave intensity using an optical detector. The intensity of the reflected laser beam waves is read by an optical detector and converted to an electrical energy display by measuring the maximum electrical voltage using a digital voltmeter. The parameters measured in the experiment investigate the relationship between the change in the concentration of the potassium

solution and the maximum voltage read on a digital voltmeter. The performance of optical sensors in the study of potassium concentration measurements using optical sensors include sensitivity, linear reach, and linearity.

Research instrument measuring potassium concentration in solution using a He-Ne laser wavelength of 632.5 nm, 5 mW of power as a source of electromagnetic waves. The propagation of the neon helium laser is guided by an optical fiber bundle in anticipation of maximizing the intensity of the propagating waves. Potassium solution used there are six variations of the sample with concentrations of 0 ppm, 2 ppm, 4 ppm, 6 ppm, 8 ppm, and 10 ppm. 818-SL optical detector for capturing and receiving reflected wave signals reflected by a mirror-specific flat wavelength of visible light (5101-Vis). micrometer position adjusts the shift position to get the maximum voltage that is read on a digital voltmeter. To reduce bias and good tool performance, an optical sensor characterization is carried out to determine the shifting of the fiber bundle sensing channel to a flat mirror which then detects the potassium concentration by making an experimental design as shown below:

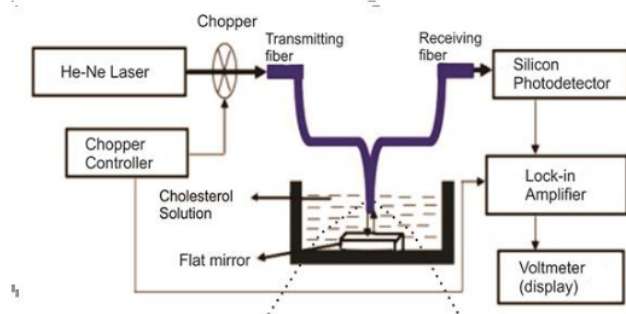


Figure 1. Optical fiber sensor design determines the concentration of potassium

Measurement of potassium concentration is done by adjusting the distance between the optical fibers of the recipient bundle and the potassium solution sample which is placed coincidentally with a mirror reflecting the zero shift. The optical fiber bundle placed on the micrometer shifts its position to shift every 50 μm . A certain shift position will get the maximum output voltage detected by the optical detector measured and obtain reflected wave intensity data through the optical fiber receiver by converting the detector output voltage as a function of the fiber bundle shift. This measurement was carried out on all samples as many as six variations of concentration including 0 ppm, 2 ppm, 4 ppm, 6 ppm, 8 ppm, and 10 ppm.

3. Result and Discussion

The profile parameters of intensity and output power of the study determine the potassium concentration of the six sample variations of the potassium concentration indicating that the optical power output will increase with increasing distance of the object shifting from the fiber bundle. This change is due to the trend of increasing voltage until it reaches the maximum output voltage. When reaching the peak the intensity of the output will decrease exponentially by changing the distance of the optical fiber to the sample. The maximum output voltage of a change in six samples decreases with increasing potassium concentration due to changes in the energy absorption of laser light waves by the solution. With increasing concentration of the solution of the sample used, the greater the energy absorption which causes the maximum stress decreases as in Table 1.

The concentration of potassium solution that varies from 0-10 ppm the output voltage starts 187.5 mV at a minimum distance. Increasing the distance to the sample solution affects the increase in output voltage value until it reaches the maximum output voltage at the optical fiber shift distance of 800 μm .

Table 1. Maximum output voltage parameters of variations in potassium concentration

| Data | Potassium concentration (ppm) | Maximum output voltage (mV) |
|------|-------------------------------|-----------------------------|
| 1 | 0 | 343.2 |
| 2 | 2 | 342.4 |
| 3 | 4 | 342.1 |
| 4 | 6 | 341.5 |
| 5 | 8 | 341.3 |
| 6 | 10 | 340.6 |

Figure 2. shows that the maximum output voltage shows a linear decrease in the increase in the concentration of potassium solution with high sensitivity and linearity.

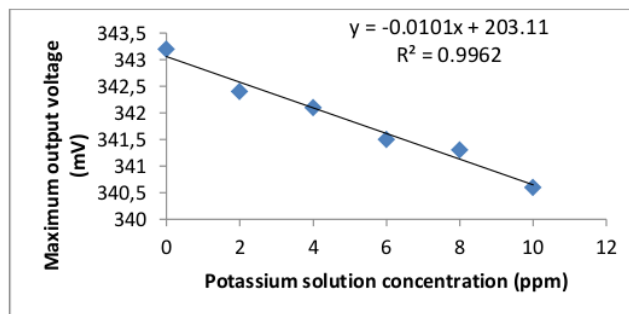


Figure 2. Output voltage against variations in potassium concentration

Based on Figure 2. the results of the analysis of the maximum output voltage on the digital voltmeter against the variations of potassium concentration using optical sensors with flat mirror reflection fields show a sensitivity of 0.01 mV / ppm and a linearity of 99.62%. This sensitivity analysis data shows that there is an approach to the sensitivity value using a quasi Gaussian file. The results of data analysis determine the concentration of potassium using this bundle fiber according to the analysis obtained theoretically [6].

4. Conclusion

Intensity profile and output power of research results determine the concentration of potassium in the solution will increase with increasing object shift from optical sensor fibers, after reaching the peak the output power will decrease exponentially with increasing distance. The performance of optical fiber sensors with the principle of the Quasi Gaussian beam approach in determining the concentration of potassium achieves high sensitivity, linearity, and accuracy with a sensitivity value of 0.01 mV/ppm, linearity of more than 99%, linear range of 0-10 ppm.

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