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IR Signal Spectrum Analysis of Liquid Sample using Fast Fourier Transform Technique

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Abstract

The prime intention of this research work has been to study electronics sensor for the detection of infection which are widely occur in food material. So electronic sensor system is designed in which IR signal was transmitted through the sample for the detection of infection. It was noted that there was changes occurs in all the performance parameters as sample kept for number of days by maintaining the same atmospheric condition. At different range of frequency, the amplitude of received IR signal was used to plot FFT and PSD response. Fourier transform of infrared signal is used to interpret interactions between sample and electromagnetic fields in the IR region. Therefore signal spectrum of IR signal using Fourier transform is a very powerful technique which provides information on the chemical composition of the sample.

Keywords: *IR signal, fourier transform, performance parameters, range of frequencies, milk sample*

INTRODUCTION

In this research work, we have designed an Infrared sensor system for the detection of infection. This detection technology is sensitive at the infectious dose level for pathogens and is ideally suited for a continuous monitor. In the present study, it has been observed that the response of the IR system in terms of Vmax parameter varied as the sample kept under required atmospheric condition. The response of the system again varied with respect to change in input frequencies [1, 2].

Similarly for IR system, as the frequency of transmitted signal changes, then there was continuous variation occurs in the Vmax response of received signal. It was noted that there was changes occurs in all the performance parameters as sample kept for number of days by maintaining the same atmospheric condition.

At different range of frequency, the amplitude of received IR signal was used to plot FFT and PSD response. Fourier transform of infrared signal is used to interpret interactions between sample and electromagnetic fields in the IR region. The probability of a particular IR frequency being absorbed which depends on the actual interaction between this frequency and the molecule of sample [3, 4].

Signal Analysis

The sample has tested by electronics system and the output response has recorded at different temperature for number of days. By using an Infrared sensor model, depending on the conductivity of sample, Vmax voltage response of the sample under test analyzed and recorded.

Signal Analysis of Sample 1

For signal analysis, milk sample 1 kept at different atmospheric condition of temperature level 30^0C, 40^0C and 50^0C and comparative analysis of electronics

model of sample 1 has performed. The production of acidic or alkaline metabolic products by organisms growing in media at varying pH may be important means of pH regulation. Many lactic acid bacteria produce these enzymes. It was noted that the pH value decreases with increasing number of days. There was an increase in electrophoresis output voltage response also. IR system is used to record the received signal at various ranges of frequencies [5]. The output responses of the testing sample are recorded and Vmax response was considered for the input frequencies 1 MHz, 0.5 MHz and 0.1 MHz. These samples have been prepared by using the classical steps which are required for sample testing during experimentation. In all samples, the lactic acid bacteria populations were counted which decided both that milk is in safety range or milk exceeds the consumable range. Second testing was used to check that milk is contaminated by the infection or not [6].

OBSERVATION AND RESULT

Infrared sensor circuit has developed to capture an analog signal that represents the strength of the received signal in time. We expect to see changes in the Vmax output voltages of the sensors when there is a change in frequency range of the sensors. It is observed that for sample 1, frequency response at the frequency range 1MHz and 0.5MHz is nearly having the same Vmax value.

Table 1: *The Output Response at 40^0C for 1MHz Frequency.*

V_{max}=14.4mV	V_{avg}=3.35v	Rise=14.7µs
V_{min}=-9.6mV	V_{rms}=7.59V	Fall=1.42 µs
V_{pp}=24mV	V_{ovr}=26.7%	+Wid=520µs
V_{top}=14.4mV	V_{pre}=13.3%	- Wid=420µs
V_{base}=-9.6mV	Prd=980.0ns	+Duty=53.1 %
V_{amp}=24mV	F=1.020MHz	- Duty=42.9%

The same samples were analyzed by transmitting infrared signal using IR sensing model. The various parameters like Vmax, Vpp, Vtop, Vbase, Vavg, Vovr, Vpre, Prd, freq, rise time, fall time, duty cycle were recorded. The performance parameters has been recorded with the help of digital storage oscilloscope and the output response at 40^0C for 1MHz frequency is mentioned in the form of Table 1 for reference.

The analysis of various parameters like Vmax, Vpp, Vtop, Vbase, Vavg, Vovr, Vpre, Prd, freq, rise time, fall time, duty cycle were recorded by changing the input frequencies of IR system for number of days at the different atmospheric conditions.

At 40 degree Celsius temperature, output response increases and given by the following relation and correlation between the values are;

$y = 0.1971x + 3.2533$…… (i)

$R^2 = 0.9275$…… *(ii)*

In Fourier transform analysis, it is essential to know which frequencies are transferred. This requires that the radiation source covers a broad spectral range and the

individual frequencies of the radiation are analyzed. As in this experimentation, sample was studied for number of days by varying input frequencies. These samples were stored for number of days at different atmospheric condition to study the heat effect on bacteria generation. In this section, FFT analysis is mentioned only for single testing of a sample. In Figure 1, original input frequency spectrum is plotted.

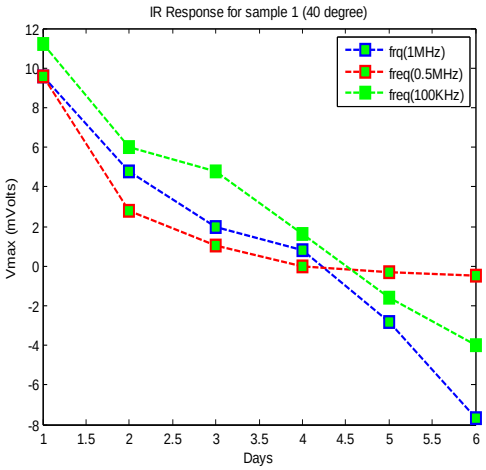

Fig. 1: *Original Input Frequency Spectrum.*

The accuracy of identifying infection species is higher at 30^0C and 40^0C temperature levels as this temperature range is the required fermentation range of temperature. Milk sample with RST culture examined here for their bacterial behaviour. Under an applied infrared signal, experiments showed that these samples have the common property of inducing voltage-dependent currents. The voltage was remained in the 12-20 mV range. Overall, there is quite a good correlation between the two sets of data for the voltage response of IR system for 1MHz and 0.5MHz. If the sample was kept at same atmospheric condition, the voltage response decreases as number of days increases.

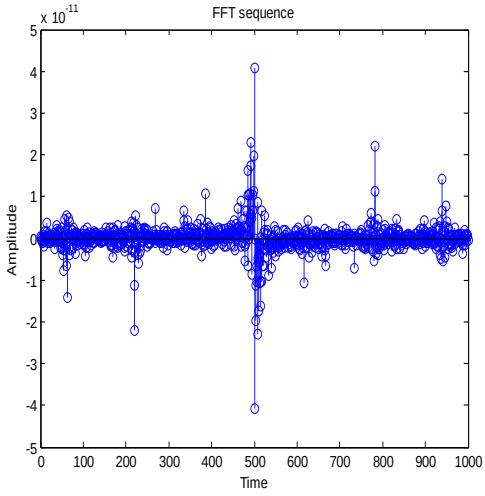

Fig. 2: *Original Input Frequency Spectrum.*

The interferogram obtained is a record of the signal (intensity) by the infrared detector as a function of the difference in the path for the two beams of the interferometer. The spectrum is obtained by carrying out the Fourier transform of the interferogram. In this, the intensity, which is a function of path difference, is subjected to transformation as a whole to give the spectrum S, which depends only on frequency. In Figures 2 and 3 original FFT spectrum of sample 1 at 40 Degree and The frequency magnitude response of sample 1 at 40 Degree is plotted respectively.

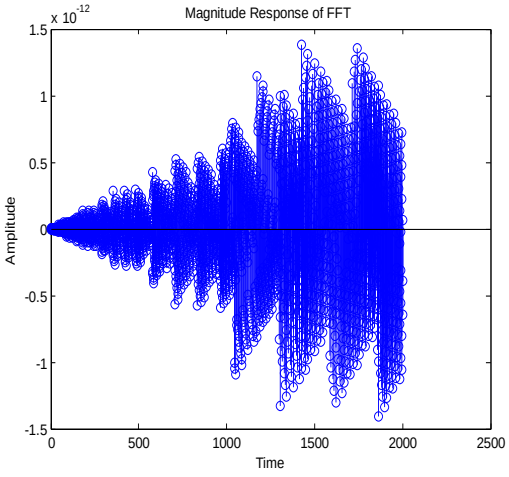

Fig. 3: *The Frequency Magnitude Response of Sample 1 at 40 Degree.*

Infrared sensor circuit has developed to capture an analog signal that represents the strength of the received signal in time. We expect to see changes in the Vmax output voltages of the sensors when there is a change in frequency range of the sensors. It is observed that for sample 1, frequency response at the frequency range 1MHz and 0.5MHz is nearly having the same Vmax value.

CONCLUSION

In the present study, it has been observed that the response of the IR system in terms of Vmax parameter varied as the sample kept under required atmospheric condition. The response of the system again varied with respect to change in input frequencies. Similarly for IR system, as the frequency of transmitted signal changes, then there was continuous variation occurs in the Vmax response of received signal. It was noted that there was changes occurs in all the performance parameters as sample kept for number of days by maintaining the same atmospheric condition. At different range of frequency, the amplitude of received IR signal was used to plot FFT and PSD response. Fourier transform of infrared signal is used to interpret interactions between sample and electromagnetic fields in the IR region. The probability of a particular IR frequency being absorbed which depends on the actual interaction between this frequency and the molecule. Therefore IR Fourier transform is a very powerful technique which provides information on the chemical composition of the sample.

REFERENCES

1. S.B.Dhoble, Dr..N.K.Choudhari, Dr.(Mrs.)A.R.Choudhari. Sensor based electronics system for the evaluation of water quality. *Research Journal of Engineering Science*. 2014; 3(11): 6-10p.
2. S.B. Dhoble, Dr..N.K.Choudhari and Dr.(Mrs.)A.R.Choudhari. Radio-frequency ph-sensing model to analyze the quality of food material. *International Journal of Advanced Engineering and Global Technology*. 2014; 2(5): 680–684p.
3. S. B. Dhoble, Dr. N. K. Choudhari, Dr. (Mrs.) A. R. Chaudhari. Identification and analysis of infection information in dairy products using electronics modelling. *International Journal of Engineering Research and General Science*. 2016; 4(3): 536–542p.
4. S.B. Dhoble, Dr..N.K.Choudhari. Neuron model to analyze the infection behavior in sample food material. *International Journal of Engineering Research & Technology (IJERT)*. 2013; 2(11): 421–424p.
5. S.B. Dhoble, Dr..N.K.Choudhari. Electronics system to study and analyze the performance parameters of sample food material. *Photon*. 2013; 118(11): 166–169p.
6. S.B. Dhoble, Dr..N.K.Choudhari. Electronics system to extract the infection information in food material. *IJAMTES*. 2012; 02(02):19–21p.

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