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MOISTURE MEASUREMENT IN DE-OILED CAKE USING INFRARED SIGNALS

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***Abstract*— Moisture of De-oiled Cake (DOC) in oil extraction industry is very important to maintain its quality and storage. It is necessary to maintain the moisture in a particular range, so there is need of accurate moisture measurement system. The existing method, weight on drying is time consuming and not suitable for continuous measurements. Some other methods are available but are so expensive. There is need to develop an accurate, low cost and online moisture measurement system. Near Infrared (NIR) signals are suitable for online application and better accuracy. NIR measurement uses reflectance and absorption principle for calculating the moisture content of sample. Higher the moisture content, higher the absorption of infrared light. By using particular band of NIR wavelength, the moisture measurement system is being developed.**

***Keywords*—Near Infrared signal, De-oiled cake, Moisture measurement**

I. INTRODUCTION

Moisture measurement of product is very important in many industries like food industries, paper industries, foundries etc. The presence of water in product has an impact on storage, transportation and further processes. Moisture level in product also decides the quality criteria of the product. Control of the moisture content in all cases is very important. Some companies extract edible oil from soybean. The byproduct after extracting oil is De-oiled cake (DOC). This DOC is used as poultry feed and also for making soya chunks. Moisture contents in this DOC cake raise the issue of its storage. If moisture content in DOC exceeds 13.5% then it catches fungus in storage. If moisture content falls below 12 % then industry looses profit due to reduction in weight of DOC. Therefore manual efforts are taken to maintain moisture level in DOC between 11.5% to 13%. There are some other methods available for measuring the moisture content of material like electrical moisture measurement, nuclear moisture measurement, microwave moisture measurement method etc. But they are very expensive and safety is key concern in those systems.[1]To measure moisture in DOC, primary loss on drying method is used. Initially the moist sample is taken; it is dried in oven and again weighted. The difference between initial weight and final weight decides the moisture percentage in sample. This test manually conducted. This is time consuming method; one test may take more than half hour to complete. It involves safety and labor cost. NIR based moisture measurement system gives instantaneous results and it is non-contact testing so that there is no possibility of changing properties due to heating of sample. Hence this research work aims to develop low cost indigenous moisture measurement system using NIR signal other than other methods.

II. PREVIOUS WORK

There is no enough documentation about this research work, no more references are available for NIR moisture measurement system on internet.John Bogart gives description of 6 moisture measurement system in 'Learn the six methods for determining moisture' e-book. This e-book provides various technologies to measure moisture content of product. It describes positive aspect of each as well as drawback. This eBook helps to choose appropriate one for our application [1]. Mirko Mesic, Venco Corluka describes the moisture measurement system using spectrometer. This system uses near infrared light of wavelength 1950 where water has strong absorption coefficient and 1800nm where coefficient is less. They used mirroring reflections. It measures moisture of sample having thickness about 5cm.The moisture is calculated by the ratio between the two different wavelengths. It determines the % of absorbance= % of moisture. This spectrometer is capable to calibrate according to sample type as per application. [2]

III.SELECTION OF IR SOURCE AND DETECTOR

To develop this system Near Field Infrared signals are used. NIR are electromagnetic waves in the wavelength region between 780nm to 2950nm. It has been observed that water has an absorption bands for four wavelengths 1.2nm, 1.45nm, 1.95nm and 2.95nm in NIR range. [2] The basic principle of reflectance and absorption of NIR is used to calculate moisture content of a sample. Higher the moisture content, higher amount of light absorbed. The Fig 1 shows the graph of absorption coefficient of water at different wavelengths.

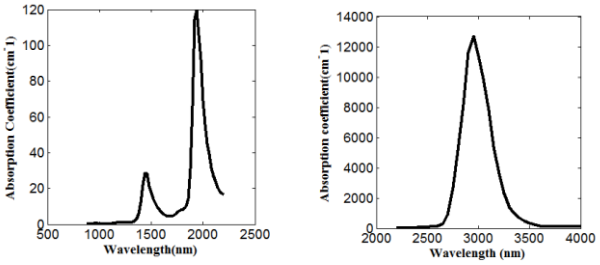

Fig.1 Graphs of absorption coefficient

The wavelength 2950nm is selected as it shows higher absorption coefficient.

A. IR Emitter

Infrared Transmitter at 2950nm used as a source of signal. It has peak emission wavelength at 2950nm.

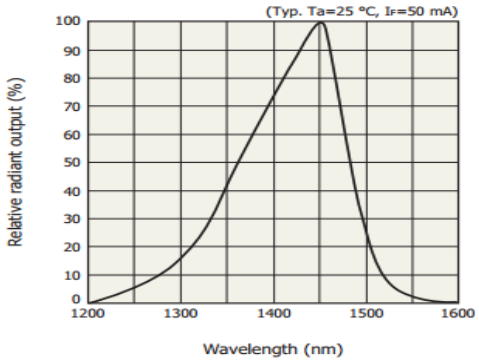

Fig. 2 Peak emission spectrum of Transmitter

B. IR Detector

Infrared detector having detection band around 2950nm, suitable for emitter. It is highly sensitive, reliable and has low noise.

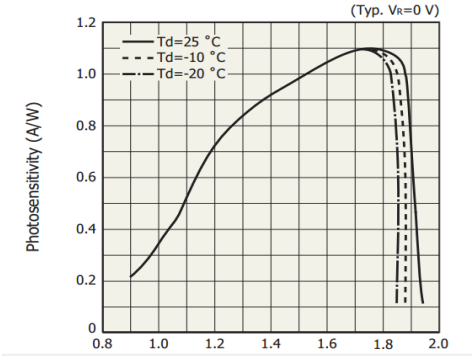

Fig. 3 Detection spectrum of detector

III. SYSTEM DESIGN

Fig4 shows the block diagram of proposed system. Infrared light emitting diode (LED) of selected wavelength is used as a source of light. For detection of infrared light signal photodiode is used. Detected signal may be weak signal with some kind of noise. Detector circuit creates some kind of internal noise also. So the detected light signal undergoes signal conditioning like amplification, filtering and converted into equivalent dc signal. For that Filter, integrator, amplifier, peak detectors are designed. Detector output is in voltage form and is given to signal conditioning system. To design signal conditioning system operational amplifier LM 324 is used. As it has standard industrial pin out for quad amplifier, high CMRR, high PSRR and negative supply in common mode which eliminate external components.The equivalent moisture percentage with that particular voltage will be displayed on the display. The process will be controlled by the micro-controller.

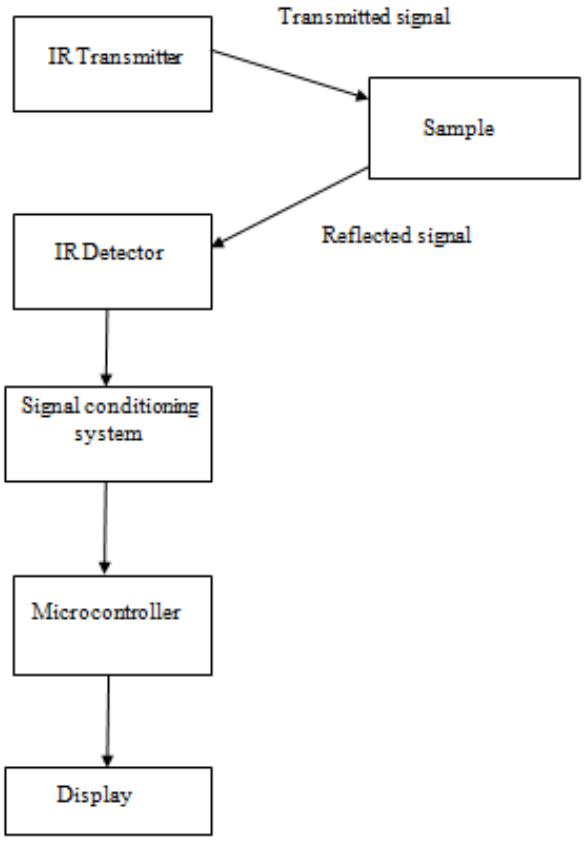

Fig4. Block Diagram of System

IV. WORKING OF SYSTEM

IR transmitter transmits rays on the sample. Due to moisture present in that sample some amount of light get absorbed and remaining get reflected. Absorption of NIR signal depends on moisture content in sample. Absorption increases with increase in moisture content. Here to reduce the effect of ambient light the square wave signal is given to the transmitter with a desired frequency. In signal conditioning system, there is subtractor. One input to subtractor is a dc signal. This dc signal is adjusted by variable resistance is such that the output of subtractor is zero for dry sample. If moisture of sample increases, some part of light is absorbed by the moist and some is reflected. Infrared detector detects this reflected light. This is a square wave signal. This signal undergoes signal conditioning like amplification as the output detector (photodiode) is in the range of mili volts. After converted it in to dc signal, it is given to subtractor. The output of subtractor will change with the moisture content. The output signal of the subtractor is amplified and this amplified voltage is proportional to the moisture content in the sample which is in percentage form. By repeating this process, more number of voltage sets are collected for different moisture and height. Using these collected results, programming will be done.

A. Printed circuit board of system

Fig.5 Manufactured PCB Of system

B. Set up of the system

Fig 5 Shows PCB of moisture measurement system. After deciding circuit for system a layout is designed in Dip-Trace software and PCB manufactured. Using this PCB, set up is done and results checked for different moisture contents.

Fig.6 set up of the system

V.RESULTS AND DISCUSSION

Results are taken at three different heights 11.5cm, 17cm, and 19cm respectively from sample towards detector. Firstly the dry sample is taken. The fixed voltage of the subtractor is set such that it shows output equal to zero voltage for dry sample at minimum height. After that known percentage of moisture is added to the sample and output of subtractor is noted for that particular percentage. Same process is repeated for other heights and results are noted and these results are shown in table no. 1.

Table No. 1 Output of the subtractor

Moisture (%)	Subtractor output Voltage (Height 1) 11.5 cm	Subtractor output Voltage (Height 2) 17 cm	Subtractor output Voltage (Height 3) 19.5 cm
0	0.02	0.22	0.05
5	0.63	0.51	0.08
10	1.13	0.65	0.14
15	1.20	0.74	0.19
20	1.29	0.79	0.34
25	1.64	0.87	0.36

This system is useful only for measurement of surface moisture of samples. At the time of calibration, sample surface was becoming dry after some time and moisture of middle portion of the sample remained as it was. Also there was effect of structure and granules size of sample on reflection of infrared signals. To check repeatability, more sets of results at different heights are taken. By comparing all the results, the output voltage will be decided for a particular percentage of moisture, and this will be done by software. Software development is undergoing for this system.

VI. CONCLUSION

This paper proposes a moisture measurement system for DOC using near infrared signals. It is found that output of the detector decreases with increase in moisture percentage in sample and output voltage increases simultaneously. This change in output voltage is related to the percentages of the moisture in sample. This system will only measure the surface moisture of sample. The output voltage changes with the respect to height, this voltage will relate with percentage of moisture through software.

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