Research Paper Engineering

Determination of Grain Moisture Content Using Ftir Spectroscopy

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ABSTRACT

Agriculture being the third largest sector of India's economy plays a vital role in stabilizing the economy of the country. Moisture determination of grains plays a significant role in enhancing the output in the agro based industry. A variety of techniques have been used for the measurement of moisture in grains. Spectroscopic moisture analysis methods are of considerable interest as they are non-destructive, efficient and accurate techniques. In the present work, grain moisture content is measured using FTIR Spectrometer. The result obtained by FTIR Spectrometer is compared with the result of oven method and digital moisture meter.

KEYWORDS Moisture content, digital moisture meter, FTIR spectrometer, Oven method.

Introduction

Wheat is a major cereal crop and an important component of human diet particularly in developing countries. Measurement of moisture content is so critical throughout all handling process from harvest, through storage, to final sale of cereals and oilseeds. If moisture is too high, there is a risk of quality reduction, or even crop loss in store. On the other hand, excessive drying is wasteful and can lead to reduced returns. Balancing these opposing risks is not easy due to the variable nature of grains within a bulk and the inherent difficulties of measuring grain moisture accurately.

A variety of techniques have been developed over time and provided improved results. Spectroscopic techniques are non-destructive, efficient and accurate techniques which can be used for multi-component analysis. These techniques can also be used for continuous online measurements. The term Fourier transform infrared spectroscopy originates from the fact that a Fourier transform (a mathematical process) is required to convert the raw data into the actual spectrum. FTIR Spectroscopy is a technique which is used to obtain an infrared spectrum of absorption, emission etc. of a solid, liquid or gas. An FTIR spectrometer simultaneously collects high spectral resolution data over a wide spectral range.

FTIR works on the basis of functional groups and provide information in the form of peaks. On basis of peaks the value of moisture, protein, fat, ash, carbohydrates and hardness of grain were determined. Peaks for water were observed in the range 1,640 cm^{-1} and 3,300 cm^{-1} on the basis of functional group H and OH.

Materials and Methods

Grain sample preparation

In preparing conditioned samples, a fixed quantity (200 g) of grain was taken after weighing. The broken kernels and foreign materials were removed manually. Distilled water was added to the sample to raise its MC to predetermined calculated levels (8.5– 30%, wb). The sample was stirred during the addition of water and the conditioned samples were stored in zip lock pouch at 2– 4°C in cold storage for at least 4–5 days, before its electrical properties were measured. During this conditioning period, the sealed jars were shaken periodically to aid the uniform distribution of moisture. The MC of each sample was determined by standard dry oven technique by grinding 5–10 g of the sample and drying it for 2 h at 130 °C. Hot-air dry ovens were used during the experimentation period to increase experimental throughput and avoid time lag. Refrigerated samples in sealed jars were permitted to reach room temperature (22°C) before opening them for electrical Measurements. Altogether, 8 samples were prepared for the room temperature studies.

FTIR measurements

Initially, the background spectrum is taken using Kbr pellets. Hydraulic press is used to convert Kbr powder into pellets. Then, Flour of each wheat variety was collected and these flour samples were converted into pellets using hydraulic press. FTIR spectra were recorded for moisture content Moisture content was determined by FTIR in mid infrared range. Peaks for water were observed in the 1,640 cm^{-1} to 3,300 cm^{-1} range. In FTIR Spectrum, the band absorbed around 1,640 cm^{-1} to 3,300 cm^{-1} shows absorbance of water molecule present in the sample.

Moisture content for each sample can be calculated using Beer-Lambert law, i.e.,

$A = \varepsilon cl$

Where,

A is absorbance.

ε is the molar absorbtivity with units of $Lmol^{-1}cm^{-1}$

l is the path length of the sample, measured in cm.

c is the concentration of the compound in solution, expressed in mol L.

Oven method

Moisture was measured using initial and final weight of the sample. In oven method, sample is kept at 130°C for 2 hrs after preheating oven. Then sample is removed from oven and bring down to room temperature. Three different readings were taken and their mean was considered as final moisture content of the sample.

Moisture content was computed as:

$MC = (W_i - W_f)/W_i * 100$

Where,

W_i is initial weight of the sample.

W_f is the final weight of dried sample.

Digital moisture meter measurement

Digital moisture meter used for grains allows fast measurement directly in the field or grain store. Three different readings were directly taken from the moisture meter and their mean was considered as final moisture content of the sample.

Comparison of moisture content

result found by different methods

The moisture content of each sample is calculated using FTIR Spectrometer, oven method and digital moisture meter. Table 1 and Fig. 1 shows the comparison of result.

Conclusions

From this research work, it can be concluded that FTIR is most reliable technique for moisture measurement of grain. This technique has overcome the limitation of some techniques used till date. The result obtained from FTIR is very close to standard method i.e., oven method, this shows that FTIR gives accurate result. It takes very less time for measurement, i.e., few seconds, which was the main disadvantage of oven method. Digital meters used till date gives result instantaneously but it works for limited range of resolution and was found not very accurate, but FTIR measures full range of moisture content. FTIR requires no external calibration, operation is very simple and this technique have maximum optical throughput with increased sensitivity. Sample preparation is also very easy for FTIR spectrometer.

Table 1 Comparison of Result with Different Methods

Sl. No.	Sample	FTIR Spectroscopy	Oven Method	Moisture Meter
1	A	8.5	8.5	9.87
2	B	12.08	12.15	14.03
3	C	14.9	14.66	14.73
4	D	17.82	17.94	19.37
5	E	20.88	20.66	20.73
6	F	23.76	23.6	23.43
7	G	27.33	27.3	27.7
8	H	30.07	29.9	"Over 34.8%", can't analyze

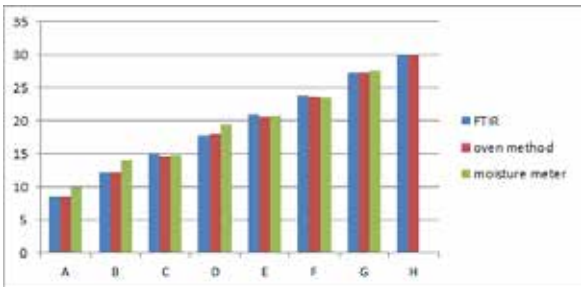

Fig.1 Comparison of Result with Different Methods

Future scope

There is no limit of possible enhancement in any technology. Following are the few possible future scopes for the present work.

- Present work was limited to grains, further this technique can be implemented on other material.
- This technique can also be used to determine concentration of other parameters present in the grains, like carbohydrates, proteins, fats etc.
- A low cost technique can be developed which gives precise result, consumes less time and measure full range of moisture content.

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