The studies and designs of sensor determining moisture of grain bulk

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Abstract

The S-LSTT sensor for determining moisture of grain bulk introduced in the article adopted the principle of capacitance method. Its appearance was cylinder and the front cone. The head of sensing and determining temperature and the circuit of changing information were set up in its inner. The sensing information was indicated the moisture content of the determined grain bulk by variable quantities of constant frequency and drawn out from the joint of connected special cable. Range of moisture measured: paddy 10 - 17%, wheat 10 - 17%, corn 11 - 18%, precision ± 0.5% (0 - 40°C)

Characters of the sensor: The sensor's was great and It was of high resolution and strong resisting obstruction. The sensing and transmitting information was stable and reliable. The value measured was objective, true, strongly representative and highly accurate The responding time was short and the output variable quantities of constant frequency were suitable for mating with the computer gathering network system which was higher speed and automatic. In addition, the sensor had powerful mechanical strength, strong antirust ability, long using life, small volume, and it was mounted easily and operated conveniently

Purpose studied

The purpose was to provide a new, economical and practical S-LSTT sensor mainly used in storage profession for measuring moisture and temperature of grain bulk quickly. It could be beforehand buried conveniently for a long time and connected with computer monitoring network to realize the function of forecasting and calculating the moisture and temperature determined in the grain bulk promptly, automatically and accurately and know the condition and change trend of the grain bulk. Naturally it provided managers reliable basis for making policy for reserving grain safely and promoted to change the backward situation of manual sample for monitoring grain condition that was heavy and consumed a lot of labor power, and material and financial resources in grain storage. And it improved the managerial level lightened the storage worker's labor intensity and reduce lose of grain storage. So it could save time, save labor power, save money. By combining with the technology of airing temperature control, it provided an effective tool for realizing the automatically monitor and managing technology of sensing, monitoring and airing control together.

Environment of sensor applied and characters of objects measured

Environment of the sensor applied

Range of temperature: −10 - 50°C
Range of humidity: 20% rh - 90% rh (relative humidity)

Objects monitored

The grain was organic. It contained many impurities, which surface was loose and inner was dense. The grain bulk had basic natures of grain non-quality and fluidity and heat insulation and dielectric of water

Request designed

1. It was requested to measure accurately and monitor effectively for a long time.
2. Range of environmental temperature and humidity must be kept the grain safe
3. The ability of resisting corrosion by acid, alkali and chemical gas such as phosphine was strong to keep precision measured
4. It had strong ability of bearing weight to reduce shape change and improve measuring exchange and using life.
5. Electrode, insulation and electronic element must have excellent adaptability to temperature and humidity to improve precision measured.
6. The quantities of objects measured were large to keep its representative.
7. The volume was small and it was requested to install and operate easily.

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8. Information exchanged and transmitted must adapt to be transported far and its ability of resisting obstruction should be strong.

Results

The sensor frame and working principle

In the project, the 'S-LSTT' sensor was designed according to the objects measured and using environment.

The sensor frame

It was convenient to be beforehand buried in grain bulk and touched with the measured objects well, its consistency repeated was good. The sensor electrode of measuring moisture was laid on its surface, which was coated with a larger antirust medium to prevent the corrosion of gases such as phosphine. The top of measuring temperature and the circuit of changing information were set up in its inner. The sensing information was drawn out from special cable joint.

Working Principle

The measuring moisture of the sensor was capacitance method. During determination, grain was put between the two poles of the capacity, that dielectric rate changed with variety of the moisture content, the sensor circuit changed the corresponding regular into the signal of constant frequency variety to output the information of measured moisture. The sensor was adopted temperature-sensitive resistor to respond the grain temperature and change the variety of temperature into the variety of resistor to output the temperature information. The signal of measured moisture content and temperature could be transmitted to the computer's CPU by joint, network, signal processor and transmitting channel to be treated with mathematical models, finally the computer output the Information of the measured moisture and temperature from monitor or printer.

Main index of the sensor and use with special microcomputer

Index of measuring grain moisture

Accuracy error; ± 0.5% (Compared with the 105°C standard method of electric oven when grain moisture was safe its temperature was in 5 - 50°C.)

Dialysis: 0.1%
Main adaptable grain:

Paddy 10 - 17%
Wheat 10 - 17%
Corn 11 - 18%
Life used: ≥ 2 years
Repeat error: ≤ 0.1%
Responding time: ≤ 20 ms

Index of temperature measured

Measuring range: -30°C - +50°C
Measuring error: ± 1°C (0 - 40°C)

Main characters

Frame of the sensor designed was new and well practical. The marked characters were showed as follows:

1. Its front was tapering, the sensor was cylinder, the outer diameter was less than 25mm, and the length is less than 350mm. And it was installed easily, and operated conveniently.
2. The inner framework of the sensor was made of steel ring, so the sensor was strong for bearing weight, sturdy and durable.
3. The electrode of measuring moisture and temperature was laid parallel on the round surface and touched with the determined grain well, so there was no obstruction to transmit the moisture of grain between near and distant the sensor. In addition, the ability of resisting out electromagnetism's obstruction was strong.
4. The sensor's sample was great (about 30kg). Its value was objective, true and highly accurate.
5. Surface of the sensor was coated with a layer medium film, which has strong ability of resisting corrosion caused by acid and alkali. it could be used in adverse circumstances where the fumigation insecticide was put such as aluminium phosphide for a long time (about 2 years).
6. Sensing responding less than 0.1ms and the sensing speed was fast. It was adaptable for mating with high speed and automatic computer gathering system.
7. Electric consumed was less than 0.6mw.
8. It had two function of measuring moisture and temperature.
9. The sensor was adopted capacitance method to measure the moisture and its value could reflect moisture content of grain bulk directly. It was useful to adopt the sensor as a determining tool of monitoring air humidity at balance or non-balance state in grain bulk at the computerized system of storage airing control, then the monitoring failure of adopting humidity-sensitive element because it confused the balance or non-balance state during measuring moisture.
10. As it was adopt the constant frequency signal which amplitude was big to output information, it was useful to transmit the information distantly and the resisting abilies caused by outer common mode, industrial noise and instant stimulating signal were strong. The transmitted signal was stable and reliable.
11. The sensor could be applied to monitor the moistures of all kinds of bulk which had the similar dielectric character of gain bulk such as rape-seed, spice, tobacco and hemp etc.
The S-LSTT Sensor

References


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