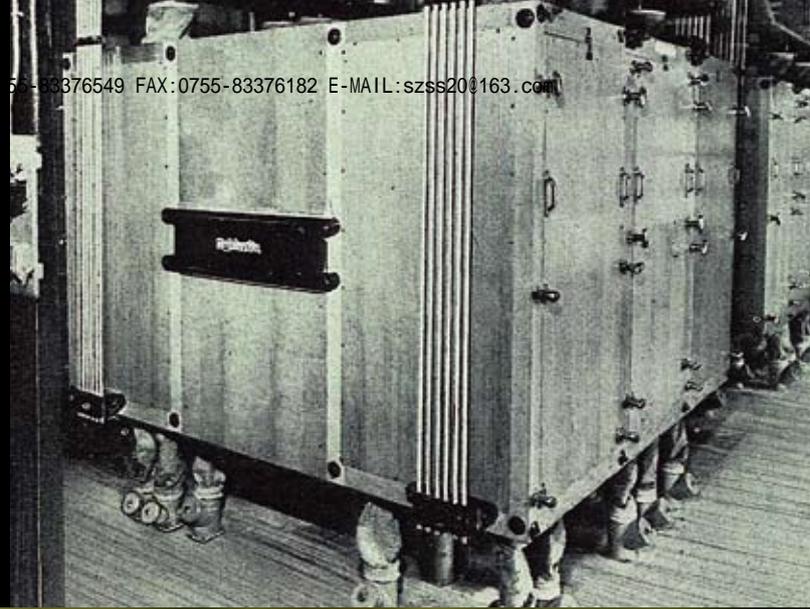


GRAIN & FEED

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Microwave moisture measurement

Hydro Probe II sensor measuring moisture in pellets on animal feed conveyor belt

By Melany George, Hydronix Limited

Keeping moisture at the correct level throughout all stages of processing can be one of the biggest challenges for feed and flour millers.

All sorts of factors affect the moisture level in the raw product: how it is stored, the humidity in the atmosphere, the variety of the grain and the particle size, to name just a few. All of these are continuously changing variables which contribute towards the amount of moisture that either needs to be added or dried off during processing.

How do you know how much water to add and when? Moisture measurement is the obvious answer, but this opens up a whole new set of questions:

- Which technology do you use?
- How does it work?
- Where do you locate it?
- What changes do you need to make to your existing system?
- Is it reliable?
- Do you have to employ specialist staff to operate and maintain the system?

- What sort of investment is needed and is it cost effective?

Fortunately, these questions can be answered. There are a variety of technologies readily available to meet different requirements and most budgets, with specialist companies that are only too keen to supply products to solve moisture measurement problems.

There are five principal technologies available on the market, although their degree of accuracy and their ability to solve measurement problems does vary. There is a choice between resistive, capacitive, infrared, nuclear and microwave techniques. The first four all have their limitations. Resistive and capacitive devices are susceptible to impurities that may lead to erroneous results. Infrared devices tend to be expensive and may be affected by dust and vapour and therefore typically lend themselves to dry, clean, controlled environments. Nuclear systems are very expensive, and although very accurate in certain applications, can be difficult to maintain. Microwave sensors are not affected by dust and vapour and have proved to be the best option in terms of ease of use, reliability, accuracy and cost effectiveness.

How does microwave moisture measurement work?

Grain or feed is passed across the ceramic face of a microwave moisture sensor, which radiates an extremely low powered electromagnetic microwave field. Due to a dipolar effect, the resonant frequency of a water molecule changes with variations in moisture content. It is these variations that are detected by the electromagnetic field. They are measured in terms of "unscaled units" which are then scaled by a process of calibration to provide a precise readout of the moisture present. The resulting signal is sent via an analogue (0-20mA [0-10v] or 4-20mA) or RS485 digital communications link back to the plant control system, allowing adjustments to the water addition process to be made automatically. Optional communication protocols can also include RS232, Ethernet (Power over Ethernet) and USB. With 25 readings taken per second, the sensor can detect changes in moisture levels almost instantaneously, allowing adjustments to be made to the process in real time. It is also possible to network multiple sensors, further reducing cabling costs and making diagnosis and multiple sensor calibration easy and straightforward.

A major advance in microwave moisture measurement was the introduction 10 years ago of the digital measurement technique. Its advantage over original analogue technology is that every sensor that leaves the factory will be programmed with identical measurement characteristics. Calibration data can therefore be shared not only between sensors but also across sites, which can reduce time-consuming calibration procedures if sensors need to be moved or changed.

For ease of integration, the sensors have on-board functionality such as signal smoothing, filtering and start/stop averaging which is easily configured and controlled by the on-board digital input/outputs. Because the units are self-contained and stand alone, they do not require any additional user interface, which helps to eliminate the potential for electronic failure in a harsh environment.

Where do you install it?

Microwave moisture sensors were originally developed for the concrete and asphalt industries, which bear similarities to the feed and grain industries. Raw materials are typically granular, they are stored in bins or silos, they are invariably moved using a conveyor and are processed using blenders, mixers and driers. Microwave technology has been successfully applied by Hydronix in the concrete industry for over 25 years.

Moisture levels in grain vary not only

between different grains and different particle sizes, but also between grain within the same batch. If a moisture measurement system is correctly installed, it will assist the feed manufacturer to calculate the moisture input required, with the benefit of consistent results.

A perfect system would have sensors positioned throughout the mill. This would ensure that the moisture level could be measured on grain exiting the bin, prior to conditioning, prior to drying and in the final product. For animal feed applications, the sensors could also be positioned before

the pellet press and before the drier to give real time control of the drier to maximise their efficiency. Each manufacturer will have his own individual requirements, with a defined budget, so a good sensor manufacturer will provide a solution that fulfils each customer's specific needs. This may be sensors installed throughout the process or just in one or two areas, as required.

Hydronix, the first company to develop the digital microwave measurement technique, has a range of sensors that can be positioned in a variety of different locations depending upon specific requirements. The Hydro-Probe II has been designed for the neck of a bin, underneath the gate, or in the material on a conveyor, and takes readings as the material flows around the sensor. For applications with a high ambient temperature, the Hydro-Probe Orbiter can be mounted above belt conveyors, again taking readings as the grain flows around it. For applications that use a screw conveyor, chute or mixer, the Hydro-Mix VI is a flush mounted sensor that enables the material to pass across the faceplate without impeding its flow.

The next step is the installation. This is simple and usually means positioning the probe underneath or in the bin, above the conveyor using a

mounting bracket, or for flush mounted sensors, cutting a small hole in the side of the screw conveyor or the mixer so the probe can be inserted. Once installed, the sensors remain a permanent feature, only being removed for replacement or repair if



needed.

It is quick and easy to verify the success of an installation. A laptop can be connected to the sensor and using the software provided and a network adapter, the operator can directly view, or "record" the signal to a file. Variables such as moisture percentage, unscaled values and even material temperature can also be directly recorded from the sensor.

What changes do you need to make to an existing system?

The good news is that very little is needed either to incorporate moisture measurement into a new system or to retrofit it to an existing system. The sensors need to be fixed in the appropriate place and then wired to the input of the plant control system. The procedure is straightforward and a competent engineer familiar with the control system should be able to make the necessary changes. Full technical support is always provided by a good sensor manufacturer, should it be needed.

Is it reliable?

Hydronix microwave moisture sensors were designed to work efficiently in the harsh, high wear environment of the concrete industry. Sensors installed in sand silos have been working successfully for over 10 years without wear or reliability issues. Since grain and other feed ingredients are considerably less abrasive than sand and aggregates, the life expectancy of a sensor in a feed or flour milling environment can be expected to be much longer.





Hydro-Probe II installed under a dryer

Do you need to employ specialist staff to operate it?

The major benefit of this type of system is that once it is installed there is nothing further that needs to be done. Mill personnel need to ensure that the sensor "sees" free flowing material and occasionally check calibration data for quality purposes. Should any recalibration be necessary to adjust for variations in the material, this is a routine process that can be carried out by the operator using the guidelines in the technical user guide.

Inaccurate or poorly calibrated measurement equipment will require frequent attention from the end user to

maintain its accuracy. This is often the case when the "working moisture range" moves away from the point at which the calibration data was collected. One cause of this may simply be the changing seasons. Unlike analogue systems, digital sensors are fully compensated within the sensor itself to allow for the effect of temperature changes. Once correctly calibrated to moisture, a digital sensor will require no further recalibration due to drift caused by temperature or vibration, or any other mechanical or electronic factors.

Is it going to require a large allocation of capital to install and operate and will the system be cost effective?

As with any capital purchase, the investment needs to be justified against the benefits that the system will bring. There are several factors that will need to be considered, including the cost of the initial purchase and maintenance and operating costs.

Feedback from existing customers indicates that initial expenditure can be recouped over a matter of months depending on system usage. With virtually no maintenance costs and minimal power requirement, the addition of a microwave moisture measurement system can be immediately cost effective in the milling industry.

Accurate moisture control will automatically lead to a reduction in spoiled material as the grain and feed can be processed with optimum liquid levels. This will enable the miller to produce a consistent, high quality product. Coupled with a saving in energy costs, the production process, and more particularly the drying process, can be more closely controlled.

So the key question is not "can you afford a microwave moisture measurement system" but can you afford not to have one?

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