Moisture measurement goes electromagnetic

Moisture measurement with microwaves allows a quick and exact determination of product qualities. AMS, a German manufacturer of quality control equipment, has developed a new technology to avoid the commonly occurring effect of density dependence.

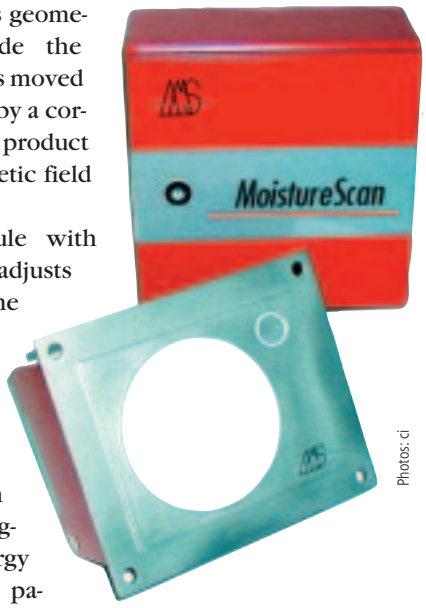
An exact knowledge of the moisture content of raw material, intermediate and final products is of great importance for a multitude of industries, among others the tobacco sector. The moisture content is essential for the processability and storability of leaf tobacco and the high quality of the finished tobacco product, hence a quick and exact as well as reliable moisture measurement method is essential during the production process.

In order to be usable in practice, the measurement method needs to fulfil certain requirements. Being used with high-speed processing machinery, it must enable quick and direct online measurement within fractions of a second. The technology must produce exact and reproducible measurement that is not influenced by colour, structure, surface or density, and it has to be robust and long-lasting, with low maintenance costs and without expensive re-adjustment.

AMS Advanced Microwave Systems, a Hamburg-based supplier of microwave-based measurement systems for laboratories and production processes, has launched a new moisture measurement system called Moisture Scan, which reportedly fulfils these requirements. In contrast to many conventional measurement instruments, it works with the so-called two-parameter measurement method of microwave resonators.

Using electromagnetism

The two-parameter microwave resonance technology (2PMR) uses the correlation between water molecules and an electromagnetic field. The electromagnetic field used for the measurement spreads within the probe. An electromagnetic field with spatial extension is, owing to the probe's geometry, produced inside the probe. The product is moved into this field, whereby a correlation between the product and the electromagnetic field occurs.



Photos: ci

Water is a molecule with strong polarity and adjusts itself according to the polarity of an electromagnetic field when that is produced. For this adjustment, energy is needed and drawn from the electromagnetic field. This energy loss is the decisive parameter.

The standing electromagnetic field shows a characteristic resonance. Electromagnetic waves spread more slowly inside a dense product or material than in the air. Owing to the filling of the probe, the propagation speed, and thus the resonance of the probe, change. By comparing the propagation speeds of electromagnetic waves inside the empty probe and the product-filled probe, the second parameter is determined.

The Moisture Lab can be used for the offline moisture determination of cut tobacco.

Examples of cavity-probes for cut tobacco and single cigarettes are shown in illustrations 1 and 2. By use of a suitable selection of components and arrangement, open resonators, so-called scattering field resonance systems, can also be implemented.
Illustration 3 is a schematic representation of the field extension inside the probe. In these probes the electromagnetic field leaves the probe on the front, where the product is placed. Illustration 4 shows the online measurement system Moisture Scan with an open scattering field probe.
On top of the probe, a hemisphere-shaped field with a maximum height of 50 mm is produced. This hemisphere represents the measuring space. The product placed within this relatively extensive volume is being measured. Open resonators allow the measurement of the moving product (see illustrations 5 and 6).

Tried and proven method

The water molecules that the product contains are influenced by the electromagnetic field. They adjust themselves according to the polarity of the electromagnetic field and the resulting energy loss is determined. Meanwhile, the propagation speed of the waves inside the product is being measured. Subsequently, the bulk density and the moisture content may be calculated by use of ▶

Illustration 1

Illustration 2

Illustration 3

Illustration 4

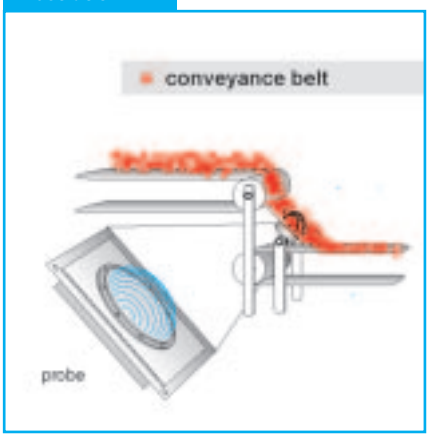
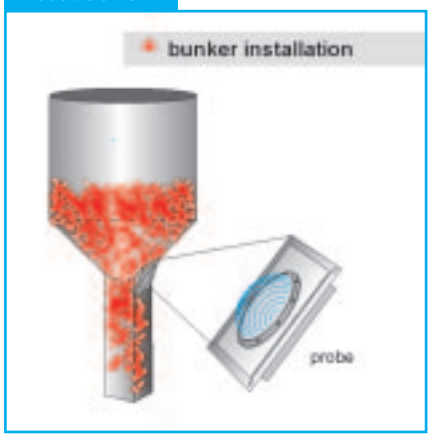


Illustration 5



the two parameters.
According to the manufacturer, the use of modern semiconductor technology enables measurement within fractions of a second. The microwaves used penetrate the whole product. Erroneous measurements owing to drying of the surface are avoided, mal-distribution of moisture is balanced.
The integration into existing production units is possible without further feed lines, AMS claims. A density-independent measurement method allows a measurement in the product stream. Constant filling height or bulk density are not necessary.
Furthermore, the measurement method provides a reproducible, long-time stable measurement with low adjustment expense, as it operates independent of colour, structure and surface of the product.
The disk probe has been constructed for industrial use. The reportedly trouble-free measurement method and the high degree of penetration into the product through the microwave field allow precise measurements. Its compact construction allows for the probe to be used in various places of installation. AMS says that the ceramic measuring area is virtually wear-free and insensitive to contamination. According to the company, the technology has proved itself in long-term use with a large number of users in other industries. **TJI report**