

Hamburg, May 2008

## Moisture Measurement in the Tobacco Industry with Microwave Resonance Technology

The exact measurement of moisture is of vital importance in almost every step of the production of all tobacco products like cigarettes, cigars or roll-your-own tobacco. A continuous and accurate moisture measurement contributes to high product quality standard and eminently develops optimization of energy consumption and ecological digestibility of tobacco production.



The TEWS Microwave Resonance Technology uses a low-energy microwave field for accurate and reliable moisture measurement in a wide range of kinds and blends of tobacco and in tobacco products. Measurement is independent of colour, surface structure and varying product density. The analyzers measure an aggregate value of core moisture and surface moisture.

All kinds and blends of tobacco leaf, stems, reconstituted and cut tobacco as well as finished cigarettes and cigars can be measured with laboratory TEWS analyzers. Online systems are available for various sites in the Primary, especially after conditioning or casing cylinders and dryers and for weight control in maker machines. Measuring of moisture of whole tobacco bales and cartons is possible with the microwave resonance technology as well as measuring water and triacetates in filter tow and pre-products.

TEWS microwave moisture meters are applied in many cigar and cigarette factories in Europe, Africa, Asia and America. Philip Morris, BAT, JTI, Imperial Tobacco and the HongTa Group apply various types of TEWS' analyzers for high level moisture or density measurement.

This article discusses

- moisture measurement in leaf and cut tobacco in the Primary
- measuring of moisture and density in rods, cigarettes and cigars in the Secondary
- the microwave resonance measuring method for moisture and density

## Moisture measuring facilities in the Primary

### **At-line moisture measurement with hand-held devices**

Hand-held moisture meters MW 1100 and MW 1100S are light-weight and easy-to-use models which let you quickly and accurately measure the moisture in a wide variety of products. Manufacturing departments, goods receiving stations or quality controllers will probably be the first to use them.

The sensor of MW 1100 is flat and dish-like at the bottom which should make full contact with the sample under analysis. The moisture content is measured and shown within one second. To measure moistures with a MW 1100S, the lancet probe with the sensor at its tip is pushed into a bale, filled box or similar package

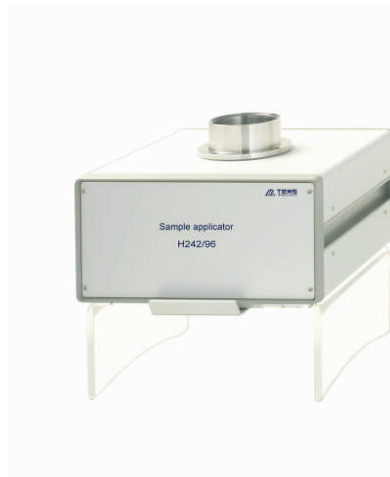


Hand-held units MW 1100 and MW 1100S for quick and accurate moisture check of tobacco bales or cartons



## Moisture check in the laboratory and at-line

TEWS Elektronik recommend laboratory moisture analyzers for comfortable measurements of moisture in tobacco leaf, stems, reconstituted and cut tobacco with sensor type SLH242-96 or with the smaller beaker sensor SLH177-40B. These units are especially suitable for the quality control in the sense of the EU / ISO 9000 through extensive preparation, retention and print outs of statistical data.



The compact unit MW 1150 is designed as a small laboratory or „at-line“ unit. It is based on the MW 11XX technology which allows readings within milliseconds to obtain sensor values quickly and reliably. The backlit 5.4“ monitor display the results up to 200 of which the unit is able to keep on memory. At-line applications use the standard 4-20mA interface to transfer values to a PLC. There are ports for a P1150-type printer and various temperature sensors.

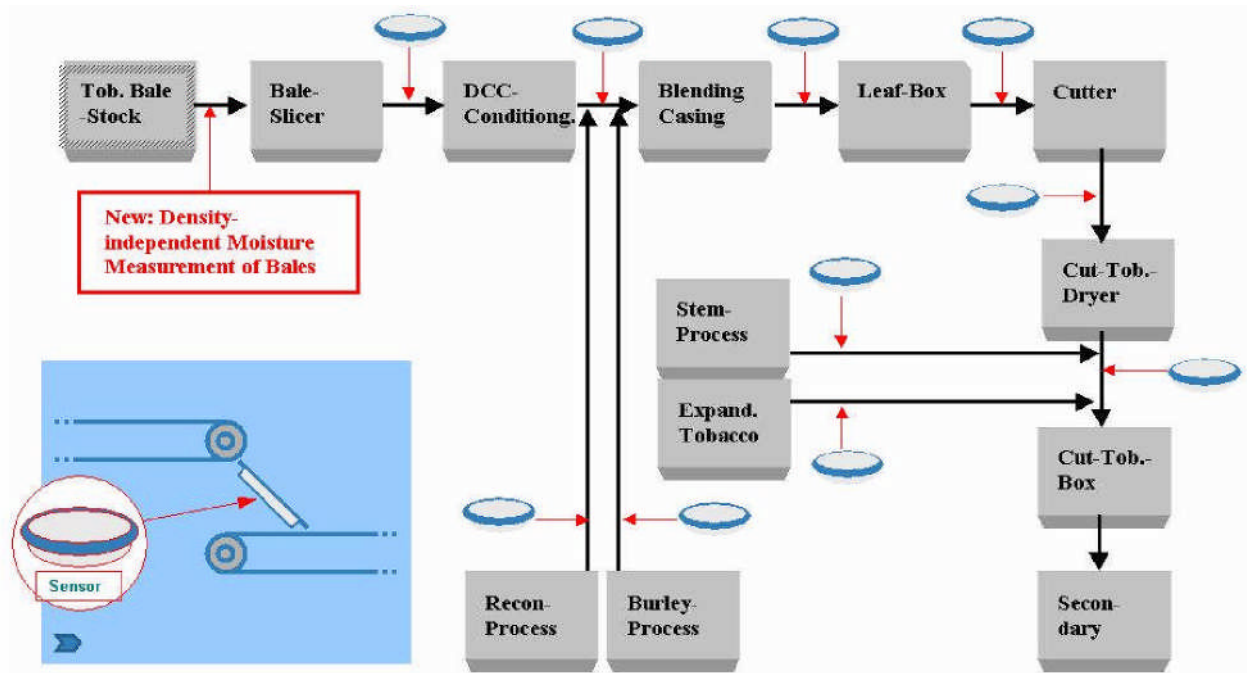
The MW 1150 is available for moisture measurements in tobacco leaf, stems, cut and reconstituted tobacco.



MW1150 with sensor SLH242-96 for moisture measurements in

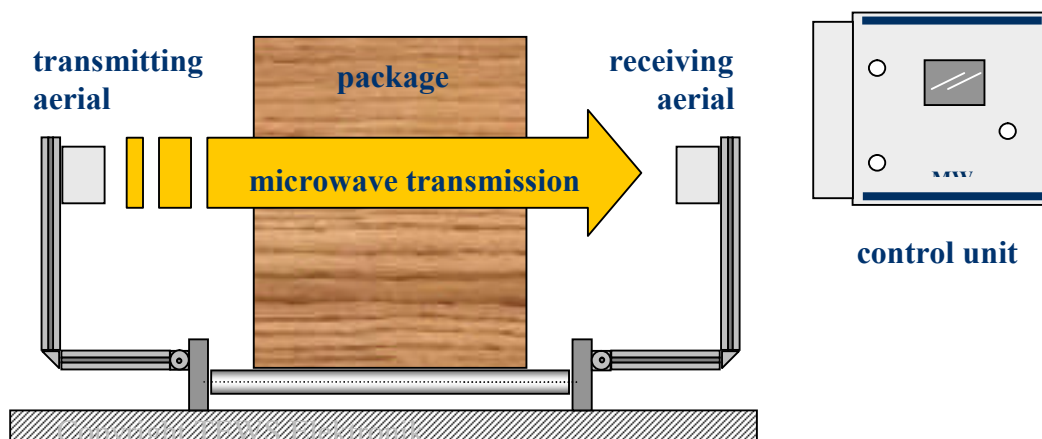
tobacco leaf,  
stems,  
cut tobacco,  
fine cut,  
pipe tobacco,  
snuff,  
reconstituted tobacco,

## Process moisture measuring facilities in the Primary



## Moisture and density measurement in bales and boxes

The application of MW-T MicroWave Transmission for moisture and density measurements in bales and cartons of tobacco or filtertow are based on a new development. This measuring technique is using complete transmission of the item by low power transmission in the microwave frequency range. The signals are analyzed and the calculation of moisture and density follows our new patented method independent of each other.





**MW-T Transmission unit:**

- contact-free core measurement technique,
- foreign body detection possible,
- easy calibration of inline measurement,
- robust technique independent of:
  - density / thickness
  - exact position
  - exact adjustment

**Possible positions for installation of process planar moisture sensors in the Primary**

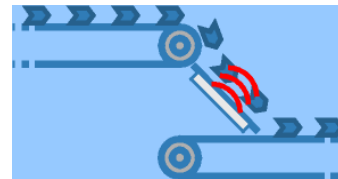
	Position	Product	Moisture range in %	Temperature measurement	Installation
1.	Before DCC (or CBC)-cylinder after slicer	Leaf tobacco at start of primary process	7-15%	Room temp. with Pt100	Sensor in a shoot or in slicer metal plate
2.	After DCC (or CBC)-cylinder	Conditioned leaf tobacco	16-22%	45-65 C with IR-temp.sens	Sensor in vibrating conveyor
3.	After blended leaf dryer	Leaf tobacco blend, all sorts	11-16%	50-65 °C with IR-temp.sens.	Sensor in a shoot
4.	After Burley toaster	Burley leaf	16-24%	35-50 °C with IR-temp.sens.	Sensor in a shoot
5.	Before stem expansion dryer	Cut stems	25-35%	40 °C with Pt100	Sensor in a shoot after metering tube
6.	After stem expansion dryer	Cut stems	12-17%	30-40 °C with Pt100	Sensor in a vibrating conveyor
7.	Expanded tobacco after reordering cylinder	Cut expanded tobacco	11-13%	25-35 °C with Pt100	Sensor in a vibrating conveyor
8.	Before cut-tobacco-dryer, after cutter	Cut tobacco	18-24%	25-35 °C with Pt100	Sensor in a shoot or vibrating conveyor
9.	After cut tobacco dryer	Cut tobacco	12-15%	45-60 °C with IR-temp.sens	Sensor in a shoot or vibrating conveyor
10.	After top-flavour or/and casing cylinder	Cut tobacco final blend, all sorts	11-16%	25-40 °C with IR-temp.sens.	Sensor in a shoot

## Inline measuring of tobacco leaves and cut tobacco in process lines

Various types of planar sensors are available for different moisture ranges of tobacco, according to the position of installation. Analyzers can be configured for a fully-automatic course and guarantee thus a simple and problem-free calibration service. The moisture readings can be transmitted to a control unit via 4-20 mA or via a serial port and can be used for directly control of the conditioning cylinder or of a dryer.

moisture range for tobacco measurement:	3 – 35 %
Tobacco temperature up to:	85°C (for expanded tobacco higher)
Accuracy of inline moisture measurements:	+/- 0.2% for cut tobacco, +/- 0.4% for leaf

### Example: installation of a inline planar moisture sensor at a transfer between conveyors



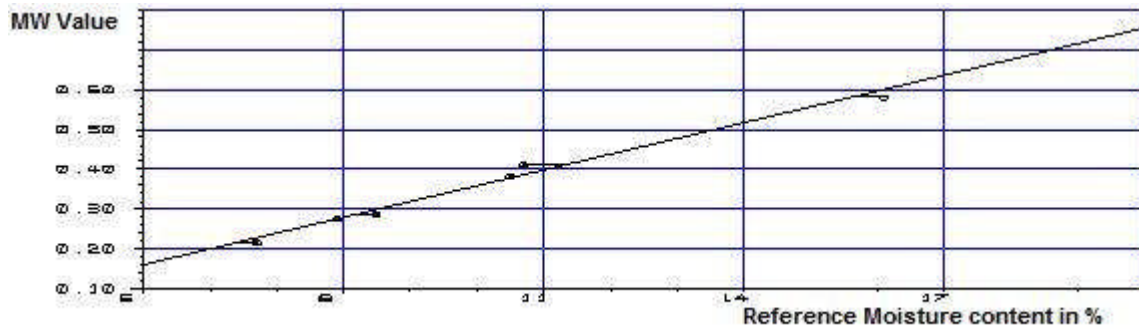
Moisture measurement in tobacco leaf after conditioning cylinder.

The moisture analyzer requires an initial calibration that can be done by the user. Up to 20 different calibrations can be stored in the analyzer. The moisture reading is widely independent of the sample's compression, as long as the sensor ceramic surface is well covered by tobacco. Readings are absolutely independent on the thickness of tobacco layer.

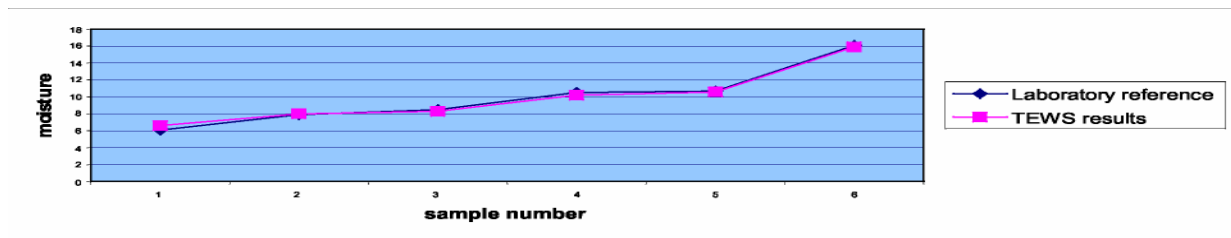
### Example for moisture calibration for stems for planar sensor P145/125:

Samples:	6 samples of mixed stems, varying size
Moisture range:	approx. 6.5 % – 16 %
Temperature:	room temperature, approx. 20 °C
Correlation:	0.99
Mean deviation:	+ / - 0.3 %
Laboratory reference method:	thermo balance Satorius MA 50

Calibration graph for planar sensor P145/125 for moisture measurements in stems

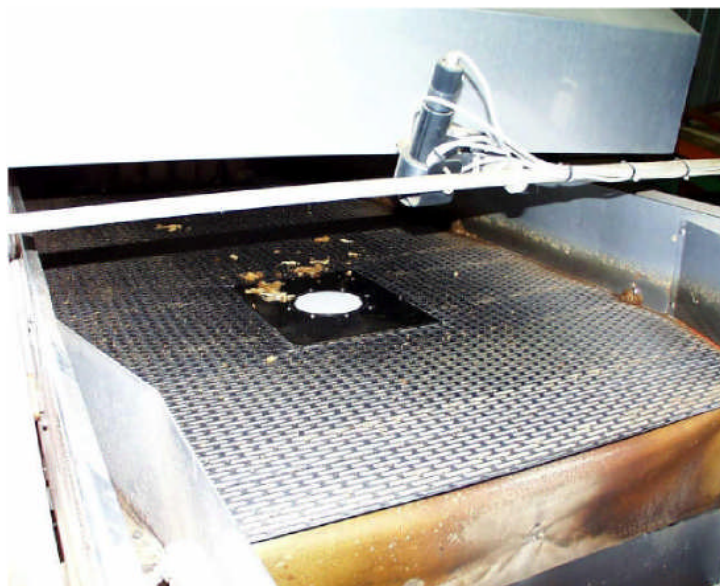


Results of moisture measurements for stems



Example: installation of a moisture sensor in a vibration conveyor

Typical sites for installation of a moisture sensor in a vibration conveyor are after DCC cylinder, after dryer or after casing cylinder.



Installation of a Planar Sensor in a vibration conveyor with additional IR temperature probe for fast non-contact measurement of tobacco temperature

## Moisture and density measuring facilities in the Secondary

### Moisture and density check of cigarettes and cigars at-line and in the laboratory

TEWS Elektronik recommend the laboratory analyzers with cigarette sensor for comfortable measurements of moisture and density in cigarettes and the sensor E177-26ex for cigars. These units are especially suitable for the quality control in the sense of the EU / ISO 9000 through extensive preparation, retention and print outs of statistical data.



MW 1150 for example with cigar sensor in metallic / plastic housing with a built-in 5" display and keypad,  
 4-20mA output,  
 connection for TEWS\_Printer P1150,  
 power adapter,  
 Pt100 connection,  
 PC connection and software  
 Tews Moisture View



### Automated moisture and density check of cigarettes and cigars

The Microwave Moisture and Density Profile Test Station with a hopper system is ideal for the quality control of a large number of cigarettes independent of the diameter, with or without filter. The patented "TEWS Method" allows precise moisture and density measurements, independent on colour and tobacco blend of the cigarettes to be measured. The horizontal cigarette transport bar guarantees optimal measuring results for moisture and density profile of individual cigarette



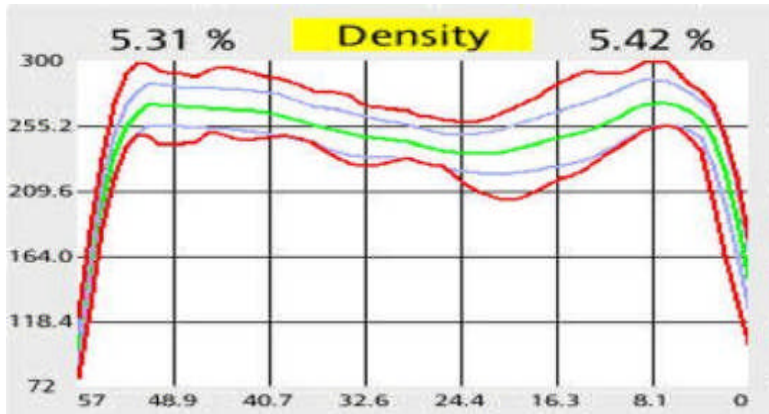
#### Cigarette Test Station's Properties

- Simultaneous measurement of moisture and density permits determination of weight
- Profile and integral measurements
- Cut position determination
- Easy touch screen operation
- Pre-calibration for moisture range 5– 18%
- Accuracy: +/- 0.1%

The moisture and density will be measured for each Millimetre of length of each cigarette. All results will be stored inside the unit as table or graphic. The system registers time, date, cigarette brand and maker.

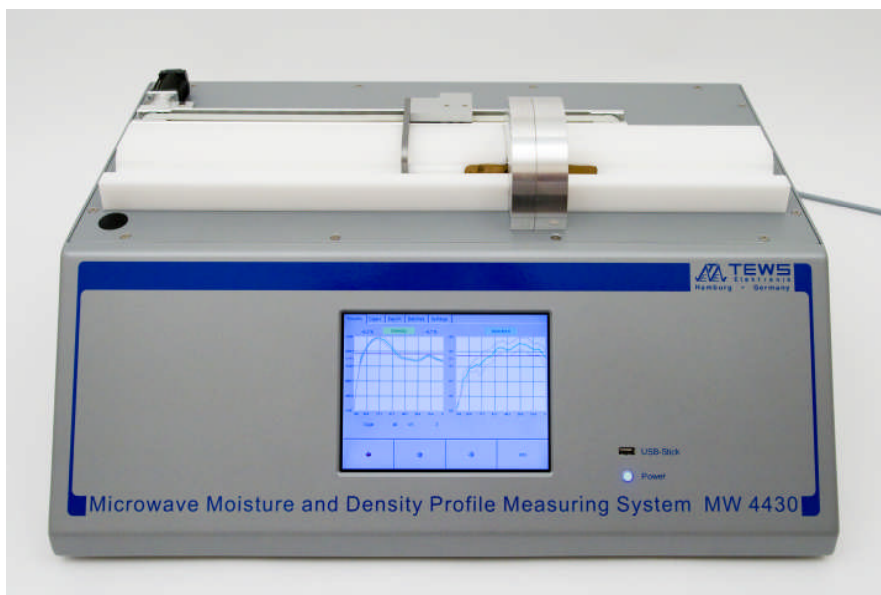
The integrated colour touch screen with its self-explanatory interface allows for precise logging of the measured data in accordance with ISO 9000

The picture shows a graphic of density profile for 5 cigarettes



#### Cigar Test Station's Properties:

- Simultaneous measurement of moisture and density permits determination of weight
- Profile and integral measurements
- Easy touch screen operation
- Pre-calibration for moisture range 5 – 18%
- Accuracy: +/- 0.2%



Cigar Test Station  
moisture and density  
profiles

## Measurement of moisture and density of cigarette or cigar rods

The high-speed microwave measuring system MW 3011 is the latest innovation brought to the market by TEWS Elektronik for parallel moisture and mass measuring in very quickly moving samples as you will find them in cigarette rods while still in the machine. High-speed system MW 3011 measures the density of the cigarette or cigar rod during production and supports process control, e.g. by helping to find the exact position of the cut.

**Microwave High-speed Weight Control Unit MW 3011 replaces Nucleonic System**

High-speed system MW 3020 includes an optional special circuitry provides a highly sensitive means of foreign particle detection. Also for the tobacco industry, there is a solution for measuring triacetin, i.e. the material that filters are made of, during fibre production at exceedingly high speed. Up to 10,000 readings can be taken every second. One-hundred percent control of the rod material produced is thus possible.



MW 3011 and sensor type E35-09 as weight control unit in a cigarette maker machine

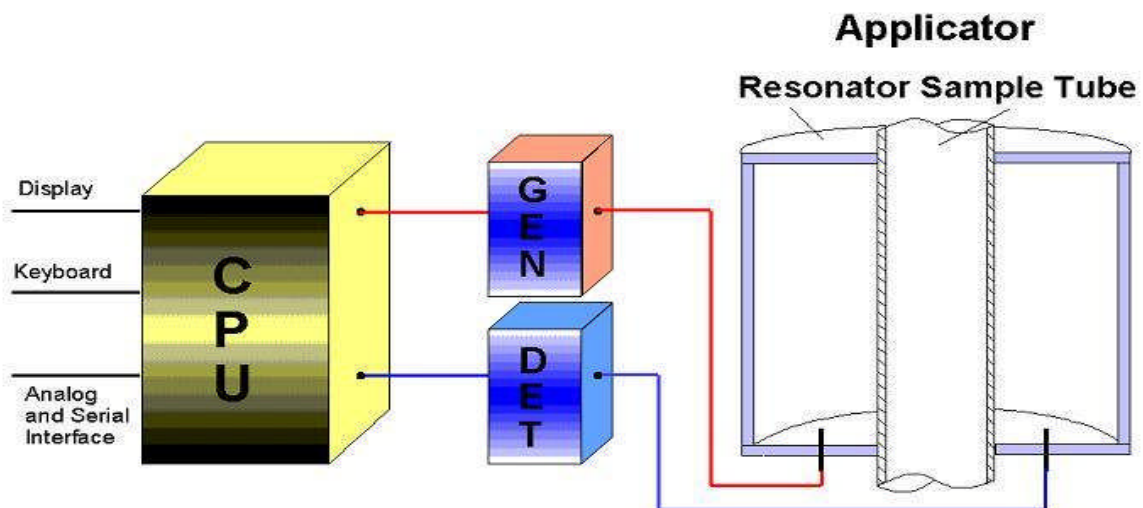
### MW 3011 Properties

Measuring speed: 10,000 readings per second  
 Accuracy (moisture): +/- 0,1% to +/- 0,3%  
 Accuracy (mass) +/- 0.5% for cigarettes  
 Microwave output less than 10 mW  
 Data outputs 2x analog outputs, RS 422, CAN interface

## The “ TEWS method “

### as microwave resonance measuring method for moisture and density

The moisture analyzer generates a microwave field inside or above the sensor. With varying microwave frequencies, a specific resonance can be measured in the sensor. If some tobacco product is placed inside or on top of the sensor, the resonance is influenced by the product and the product's water content. Because water molecules considerably absorb energy from microwave fields, the product's moisture can be calculated from the change of the resonance's parameters. In particular, a resonance shift and a change of attenuation are measured. By measuring two parameters, a moisture value can be determined while the influence of density is compensated. The absolute moisture level (% of the product's mass) is obtained by an initial calibration.



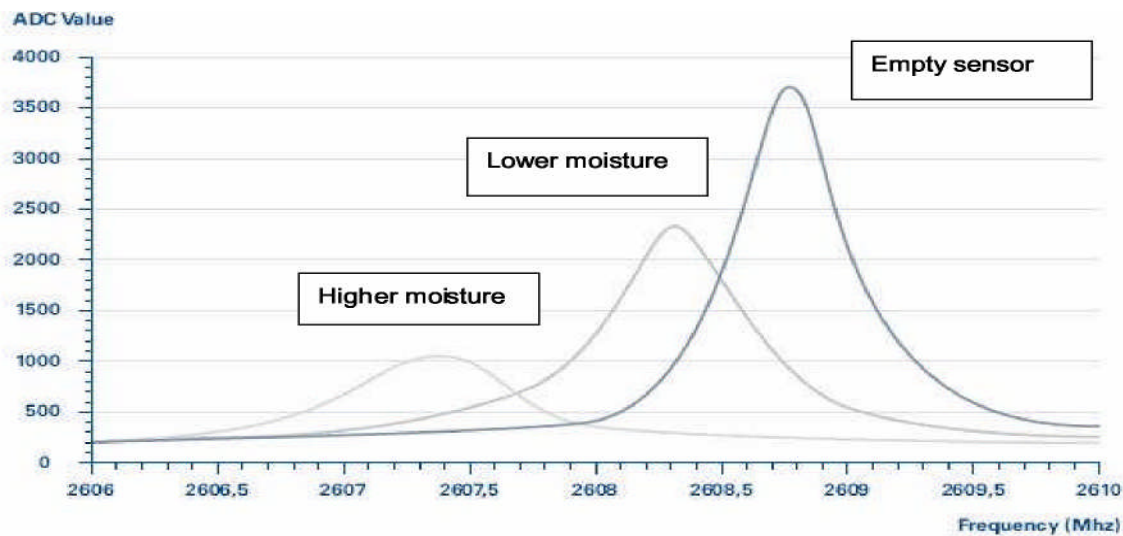
#### Microwave moisture analyzer components

Water molecules residing on the surface or in the pores of tobacco substances align themselves with electromagnetic fields while drawing energy from the field. The interaction between microwave fields and water molecules is measured and used to calculate and display a moisture value. Since microwaves will penetrate deep into the product, the technique will detect water on the surface and inside the tobacco material as well. The sensor's microwave field is working with less energy than a cell phone and therefore doesn't heat up the measured product and is not harmful to health.

Filling or covering the sensor with a tobacco product – e.g. leaf or cigarette – will influence the exact position and strength of the resonance. These changes largely depend on how much water the product contains. Resulting resonance readings will be proportional to the moisture. The influence of varying product density or the amount of product piled on the sensor are compensated. Multiple readings (up to 10.000) are taken per second.

The patented “TEWS method” based on:

- Dipole properties of water molecules
- Electric fields in GHz frequency band



Measured resonance curves are typical for the empty sensor and for dry and wet tobacco samples.

The water in the product changes:

- the resonance frequency and
- the amplitude of the peak

This 2-parameter measurement allows to separate and to measure:

- the moisture independent of density or particle size
- the density independent of moisture

### Advantages of microwave resonance measurement

- Measurement is very fast and therefore appropriate for online use in process lines,
- measurement is very accurate,
- measurement is independent of changes of product density, material flow rate, colour and surface structure,
- measurement regards moisture on product surface as well as in product core,
- measuring is non-destructive,
- measuring systems don't require any chemicals or other consumables,
- measuring systems are easy to operate,
- measuring systems are maintenance-free;

For further information about the application of TEWS Elektronik’s microwave resonance measuring systems please contact:

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