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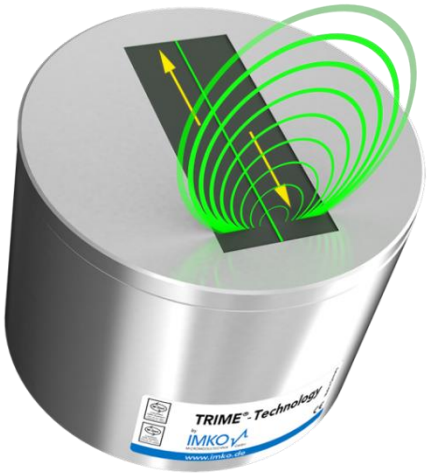
Comparison of SONO and Microwave Probes

Note: SONO Moisture Probes are not Microwave Probes!



The SONO-Probe as a „Moisture Tomograph“
Green shows the guided radar wave which expands with the speed of light. Similar to a computer tomograph the material is measured disc-shaped and layer by layer which offers many advantages in comparison to conventional probes:
Conventional probes show dependencies from:
The material height above the probe´s surface, the structure of the material, from the fines content of the material, and from many other disturbing factors which can e.g. influence an unguided microwave.

Since 2010, when having reached an accuracy of ±1 Picosecond (10^{-12} seconds, this corresponds to 1 Terahertz) for measuring the radar travel time, IMKO can offer the SONO moisture probes for applications in the process industry. The **TDR** measurement principle (**T**ime-**D**omain-**R**eflectometry, also called cable radar) has been well established in the last 20 years for challenging applications in the process industry. With the SONO TDR-method a guided radar pulse travels along a radar track with nearly light speed and a measurement field propagates in slices above the probes surface. The measurement field of SONO probes adapts itself to the height of material at the surface, at lower height it contents itself with lower material (up to certain limits), at larger heights the measurement field penetrates into the larger material volume. Influences from e.g. larger gravels will be quasi averaged with this method and other undesirable influences due to plant parts are minimized. „Guided wave radar“ instrumentation is also a proven technology for level measurements in the industry.

Microwave Probes
Microwave probes (as well capacitive probes) are using „unguided“ measurement fields which penetrates into the material. Therefore such probes responds with measuring errors due to changes in the height of the material and other influences above the probes surface. The electrical field has to flow out of the probe and later enter again into the probe and therefore has to pass twice a thick ceramic plate (up to 10mm thickness) when sending and receiving a microwave signal. Dependent on probe type the most sensitive area lies in the center of the probe because the transmitter is placed below the ceramic surface. Disturbances with e.g. larger gravels or coarse and fine particles as well as influences by plant parts can have significant effects. If all input variables (disturbances) are adjusted exactly, then it is possible to measure moisture exactly. If only one of the many parameters deviates, then a new re-adjustment of a microwave probe is necessary. In practice a microwave probe can be considered as a system for experts.

Points of comparison for SONO and microwave probes in applications for construction-, food-, chemical-, petro- and pharma industry:

Topic	SONO probes	Microwave probes
Grain size and grain form	There are nearly no dependencies, from e.g. fine sand up to 32mm gravel size as well round or broken grains, respectively split.	Considerable dependencies, few changes in material composition require calibration adjustments. E.g. problems to determine the moisture of gravel.
Fine particles	Variations in fine particles have no influence.	Measurement fluctuations due to variations in fine particles. General problems with high amounts of fine particles.
Calibration at commissioning	A SONO probe can be commissioned without calibration for sand, gravel and other materials. A fine adjustment of +- 0.3% is possible with a universal calibration curve.	Depending on material composition a time and cost consuming precise calibration is necessary at commissioning.
Long-term stability due to abrasion	Auto-Correction allows long-term operation without recalibration.	Due to abrasion the probe has to be recalibrated permanently from a technician. A time and cost intensive process.
Conductivity, temperature	Nearly no dependencies, the conductivity can be determined separately with the 1GHz TRIME method. High temperature versions are feasible up to 200°C.	Considerable dependencies.
Measurement field expansion	Dependent on SONO probe type, measurement volumes from 50cm^3 up to 1m^3 can be measured. With the guided radar wave, the measurement depth can be constructively specified.	Considerable dependency on bulk height and from the location of the field which is concentrated and can be disturbed in the center of the probe. The field has to pass twice a thick ceramic plate.
Pertubations of the measurement field	Nearly no influences due to guided radar wave.	Considerably influences by plant parts, etc.
Probe internal preprocessing	Intelligent preprocessing at high frequency rates with pre-checks for physical plausibility, pre-averaging as well as different powerful and new filter algorithms. Increased reliability to a downstream control system.	Depending on probe type up to 100 measurements per second which can be filtered and averaged.

Topic	SONO probes	Microwave probes
Service life of the probe head	Depending on sensor type the SONO probe head and the electronic are separated, i.e. in case of wear the probe head can be changed using the existing electronic. The probe head of SONO-MIX consists of a solid plate of tungsten carbide with special Silicium-ceramic composite, made for highest robustness and extremely long lifetime.	Probe head and electronic are usually an integral unit, except at mixer probes. With a relatively large ceramic plate the risk of breakage is high. A steel frame for holding the ceramic plate is exposed to abrasion and must be changed after months, depending on workload.
Control of water/ cement ratio	Is possible with the SONO-MIX due to precise separation of moisture and conductivity, opening control of w/c-ratios down to 0.40	Not yet known
Moisture measurement range	SONO probes can measure up to 100% water. This allows to control the solids content in liquids up to 100% water.	Not yet known
Control of further material parameters like viscosity.	SONO probes measure in parallel the high frequency radar attenuation with the revolutionary TRIME method which allows further new control of specific material parameters in many applications.	Not yet known

Starting a new chapter in material moisture measurement with the innovative SONO process moisture probes and the revolutionary TRIME technology.

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