Technical Data

LIEBHERR

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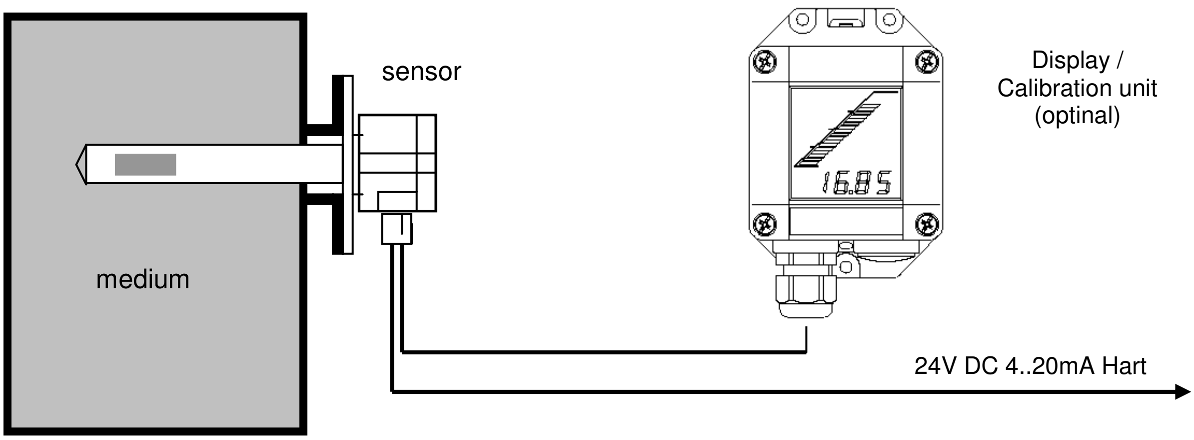
System Overview



"Intelligent Sensor"

A sensor can be designated as an "intelligent sensor" which additionally features a fitted µ-computer allowing an extended functionality:

- measurement sequence control
- signal processing
- disturbance variable measurement
- disturbance variable compensation
- automatic self-calibration
- interface (communication with the controlroom units)
- error message

An intelligent sensor is reproducibly. During operation, each item receive specific calibration data via the interface, which will then be stored in a non-volatile semiconductor in the sensor. Calibration data are a.o. disturbance variable correction tables, adjusting factors, offset, serial number, date, software version. For special applications, this interface can also be used to transmit a different software to the sensor without having to remove the same.

The sensor makes available the relevant measurement result in a fully processed format and at the correct time. This reduces the requirement for data transfers to a minimum. If many sensors are connected to a controlroom unit, this will also provide some relief for its computing capacity.

An essential advantage of an intelligent sensor is the fact that all measurement tasks including the solving of any problems are contained in a single component.

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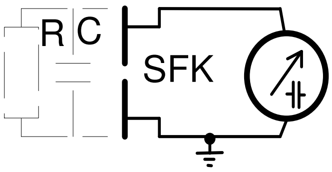
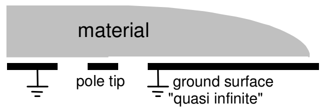
The RF absorbtion and Frequency Shift measurement procedure



The object to be measured will be brought before the plates of a stray field antenna SFK as a so-called dielectric; this antenna can be applied as a pole tip, strip, or comb behind a wear protection.

If the SFK is supplied with high frequency energy, the arched field lines will permeate the material. The RF field will change depending on moisture/water content. The dielectric loss resistance designated as R in the model will reduce for material with watercontent and has similarly detrimental dependencies as the conductive measurement method.

The capacitive shares of the SFK behave somewhat more advantageously, in particular with regard to their electrolyte contents.



Due to the dipol character of the molecules, liquid water (ε_r = 80) - in contrast to dry crudeoil, parafine (ε_r = 2,15 - 2,2) - has a very high relative dielectric constant.

$$C = \varepsilon_r \cdot \varepsilon_0 \cdot k \frac{A}{d} \qquad \varepsilon_0 = 8.85 \text{ pF/m}$$

Thus, ε_r is also linearly proportional to the water content and to the capacity C, as "ε_0", plate clearance "d", plate surface "A", and form factor k are constant.

The SFK should be determined ground-related at a high measurement frequency (>>10 MHz) and with a real frequency shift measurement without any influence by the dielectric losses.

The water value can then be processed electronically. (Temperature compensation, signal transmission, evaluation, indication).

The interrelationship water contents and C can be deemed to be linear within a wide measurement range.

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Dissolved electrolytes (Salinity Influence)

Even for products with high conductivity (salt, carbon, metal particle contents) the Litronic moisture sensor responds sufficiently clearly to water contents in the product. The reasons for this are: the RF absorbtion and Frequency Shift measurement and the existing amplitude control. In the case of the Litronic moisture sensor, the RF absorbtion (ion conductivity) will be continuously re-fed by the amplitude control. However, water dipoles contained therein clearly shift the dielectricity and thus cause a change in capacity.

As the conductivity of the material is not evaluated, any dissolved electrolytes (pH value) have an imperceptible effect on the measurement result.

In spite of major variations in the dielectric losses the effective plate voltage *U* - in contrast to the dielectric procedure - will be kept constant (amplitude control). As the plate clearance d and the plate surface *A* also remain constant, the electric field strength *E* is also constant. The shift *D* (electric flow density) is proportional to *E*. The water contents of the material will then imperceptibly change the measurement volume.

For consideration - the homogenous field

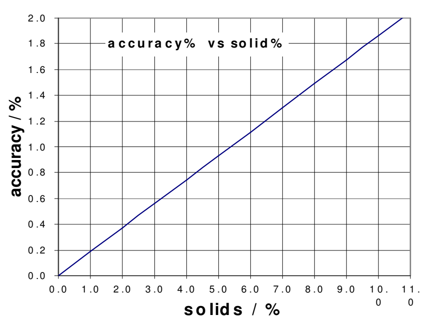
$$E = \frac{U}{d} \qquad D = \varepsilon \cdot E \qquad Q = D \cdot A$$

and the inhomogenous field:

The complete surface *A* hold the charge *Q*. For the electric area flux originating from this charge, the following holds:

$$\Psi_0 = \oint_A D dA = Q$$

Solids Influence



Solids (ε_r = 5..10) - in contrast to dry crudeoil, parafine (ε_r = 2,15 - 2,2) - has a high dielectric constant.

If solids <5% of Volume constant, it is not necessary to compensate this error by curve-parameters.

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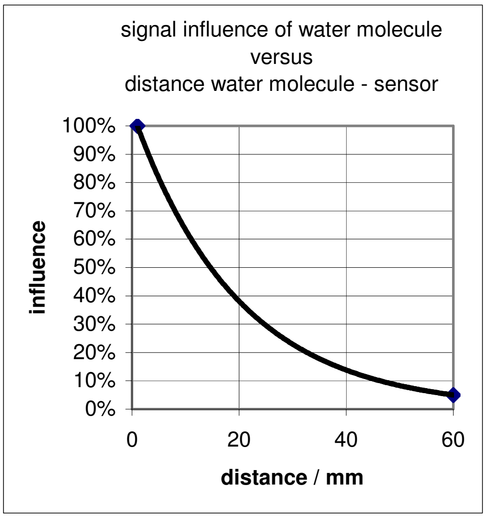
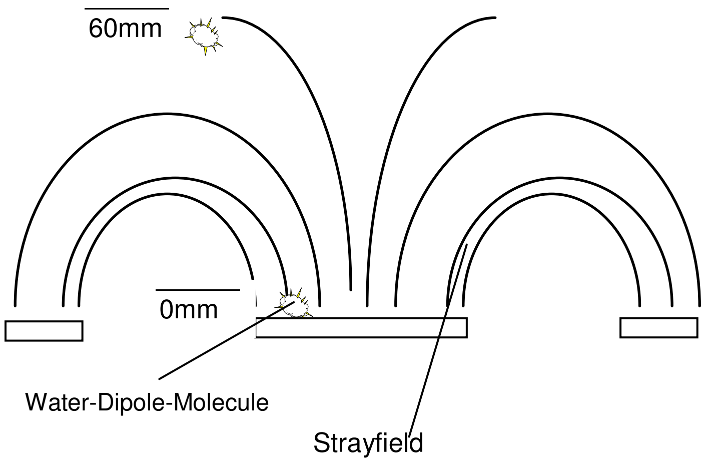
Measuring dept





Air Gas Influence

Air/Gas (ε_r = 1) - in contrast to dry crudeoil, parafine (ε_r = 2,15 - 2,2) - and water (ε_r = 80), has a low dielectric constant. Gas has more influence if water contens is high.

There ist no relevant gas error within a measuring range of <5%. (Water / Volume)

Temperatur Influence

The Litronic FMS-Sensor includes 2..5 integrated temperatur sensors for full factory temperatur compensation (strayfield condenser, oscillator and medium).

Parafine Influence

Parafine crudeoil, parafine (ε_r = 2,15 - 2,2) - have the same relative dielectric constant. A low parafine error makes no compensation necessary.

Density Influence

If the medium changes, it is possible to compensate this error by curve-parameter.