Wireless Moisture and Leak Detection

VTT TECHNOLOGY

We offer technologies for monitoring the moisture content in different materials. This will help to prevent the unwanted moisture damage and to control the drying process of different materials, such as concrete.

SOLUTION

With wireless technologies we can measure the moisture content in different materials such as wood, gypsum and concrete, and also in biofuels and crops. The moisture measurements are performed with wide-band radar technology and RFID sensors.

IMPACT

Wireless moisture content monitoring and control leads to new business opportunities in several application areas: Building Structure Monitoring (concrete drying and wall humidity), biomass drying process monitoring, biofuels moisture content monitoring etc.

Process

- Specifying measurement needs
- Design of system architecture
- Installation of measurement system
- Monitoring and data analysis
Example: Measurement of moisture in wood chips

- Installation of a test setup for monitoring the drying of Biomass at Hakevuori, Finland
- RFID sensors for measuring humidity and temperature
- In-house developed wireless sensors
- Weather station
Moisture Radar

- Measurement of structure moisture with wide-band radar.
- Test measurements on plywood, gypsum plate, concrete.
Passive UHF RFID Temperature and Humidity Sensor

- Passive, i.e. no battery included. All the power extracted from reader RF field.
- External μC controls the measurement of temperature (resistive) and humidity (capacitive).
- Current consumption:
  - \(\sim 10\mu A\) (\(Vdd=2V\)) when measuring,
  - \(\sim 100\mu A\) when writing flash
- In situ calibration: With 200pF and 400pF reference capacitors, resolution \(\sim 1pF\)
- Read range 0.5 meter demonstrated
- Uses commercial capacitive humidity sensor, but any capacitive (printed) sensor can be applied.
- Demonstrated in wall and in concrete during 2011.
Passive HF RFID Temperature and Humidity Sensor

- IDS HF RFID Sensor chip
- Sensirion SHT21 sensor
- Piloted in concrete drying and wall humidity measurements
- Can be read with handheld reader.
Moisture and temperature tag: Smart phone readout

- Range a few cm
- Electronics for Wheatstone bridge, for e.g. a strain gage can be added
- Tag can also be manufactured with roll-to-roll printing and hybrid integration of ICs
UWB Impulse Radar Humidity measurements

- The theory of determination of the moisture content with impulse radar is based on the measurement of travel time and amplitude of short electromagnetic impulses which travel through the material.
- Velocity of impulses is strongly influenced by the amount of water in the material. The relative permittivity of water is higher than of many other materials.

\[ v = \frac{c}{\sqrt{\mu_r \varepsilon_r}} = \frac{c}{\sqrt{\varepsilon_r}} \]

<table>
<thead>
<tr>
<th>Material</th>
<th>Relative permittivity</th>
</tr>
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<tbody>
<tr>
<td>vacuum</td>
<td>1</td>
</tr>
<tr>
<td>air</td>
<td>1.000589</td>
</tr>
<tr>
<td>paper</td>
<td>3.85</td>
</tr>
<tr>
<td>wood, dry</td>
<td>2.6</td>
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<tr>
<td>water</td>
<td>80 (20 °C)</td>
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<tr>
<td>rubber</td>
<td>7</td>
</tr>
<tr>
<td>plastic</td>
<td>2 – 3.5</td>
</tr>
</tbody>
</table>
UWB Impulse Radar Humidity measurements

Test measurements of moisture in the wood block
Additional information

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