Moisture Measurement on Bulk Materials

LB 350
Moisture Meter LB 350

The Moisture Meter LB 350 has been designed to measure the moisture content of a variety of different products. For example:
- in bunkers
- on weighing tanks
- on feeding tanks

The large measuring volume of up to 1 meter in diameter assures a representative measured value.

**Benefits**

- representative measured values due to large measuring volume
- accurate measurement due to highly sensitive $^3$He counter tubes
- Not effected by:
  - Temperature
  - Pressure
  - pH value
  - Color

**Principle of Measurement**

The nuclear method of moisture measurement is based on the principle that fast neutrons are slowed down by scattering the hydrogen nuclei.

Fast neutrons are hardly slowed down by scattering materials of higher atomic numbers.

A cloud of slow neutrons is created around a source of fast neutrons, and its concentration essentially depends on the hydrogen content of the surrounding product.

By combining a source for fast neutrons with a detector for slow neutrons, the measurement system is capable of determining the hydrogen content without contacting the measured medium. Since water contains hydrogen atoms (H$_2$O), the volume moisture is indicated directly.
Configuration with Bunker Probe

The probe is installed in the outlet section of a bunker or a continuous flow tank so that the built-in neutron source is sufficiently surrounded by material in accordance with the effective volume. The probe is mounted in a dip pipe, closed at the bottom end, which is installed into the tank at an angle of approx. 30 - 45° to the horizontal. Ideally, the wall thickness of the dip pipe should be between 3 to 5 mm to minimise signal attenuation at the detector. (The signal is reduced by about 5% per each 1 mm of steel.) We recommend using a hardened dip pipe, or a dip pipe with ceramic jacket, to ensure a long life time, even when working with abrasive products.

**Bunker Probe LB 6666**
In this arrangement, the counter tube, radiation source and preamplifier electronics are accommodated in one housing.

**Benefits**
- representative measured values due to optimum measurement position in the volume flow
- accurate measurement results since the signal is not reduced by container walls

**Engineering data**
We need the following technical data to plan the optimum system configuration for you:
- Product
- Bulk density
- Measuring range
- Ambient temperature
- Container drawing
- Container wall construction

**Applications**
- Sand
- Vitreous sand
- Coke
- Sinter mixture
- Iron ore
Configuration with Surface Probe

The Surface moisture measurement system should be used when:

- the dip pipe for the bunker probe is subject to a high level of abrasion from falling product
- the product may fall directly onto the dip pipe
- interferences in the material flow due to a dip pipe are likely to occur
- the bunker has to be accessed for revision purposes

The surface moisture probe LB 7410 is mounted directly on the tank. The steel wall of the tank should not be thicker than 20 mm so measurement sensitivity is sufficient.

Mounting frame

A mounting frame is sometimes recommended because it:

- provides accurate measured values, since the measuring signal is not reduced by the tank wall
- allows fast mounting, since the holding device for the moisture measurement is integrated into the mounting frame
- offers a long service life due to a wear-resistant ceramics surface

The mounting frame has to be installed in a opening prepared in the tank wall.

After an operating time of several years, a broken wire in the integrated conductor loop indicates that the ceramics surface is worn down.
Bulk Density Compensation

Bulk density compensation increases the accuracy of the moisture measurement if the bulk density of the product is fluctuating. Bulk density compensation consists of a scintillation detector and a shielded Gamma radiation source. An additional measuring amplifier determines the bulk density in order to compensate for the moisture measurement.

Depending on the measurement path through the tank, different measuring systems should be used to measure the bulk density:
- transmission measurement
- backscatter measurement

Transmission Measurement

Radiation emitted by a Gamma source is attenuated as it passes through matter. If the bulk density changes, the attenuation changes as well. A transmission measurement is possible only with transmission paths of max. 700 mm; however, compared with a backscatter measurement it offers a decisive advantage: the indication is more representative, since a larger measuring volume can be covered.

Backscatter Measurement

Radiation emitted by a Gamma source is backscattered by the product being measured. The intensity of the backscattered radiation is an indication of the bulk density. If a surface probe is used instead of a bunker probe, then the backscatter measurement can simply be installed into the mounting frame.

Radiation Protection

The controlled area of 3.700 MBq neutron radiation sources ends in air (dose rate > 3 µSv/h) already in a distance of 80 cm from the source. For most applications, the controlled area is within the vessel’s dimensions and is not accessible, which minimises radiation protection efforts.
## Technical Data LB 350

### Evaluation unit LB 350

<table>
<thead>
<tr>
<th>Design</th>
<th>LB 350-1: aluminum wall housg. IP 54</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>weight approx. 4.3 kg</td>
</tr>
<tr>
<td>LB 350-2:</td>
<td>19&quot; rack 3HE</td>
</tr>
<tr>
<td></td>
<td>weight approx. 4.8 kg</td>
</tr>
<tr>
<td>LB 350-3:</td>
<td>19&quot; rack 3HE</td>
</tr>
<tr>
<td></td>
<td>accommodating 2 channels for moisture density compensation</td>
</tr>
<tr>
<td></td>
<td>weight approx. 6.3 kg</td>
</tr>
</tbody>
</table>

### Mains

- **AC voltage:** 250/230/125/24VAC
- **+10% to -15%, 47-65Hz**
- **DC voltage:** 24VDC (18 - 36VDC)

### Power consumption

- max. 25 VA

### Operating temp

- 0 ... +50°C (32 ... 122 °F)

### Storage temperature

- -40 ... + 70°C (-40 ... 158 °F)

### Analog output

- Moisture signal 0/4 - 20mA, isolated, load: max. 500 Ohm

### Detector connection

- 7 - wire
- Supply (+/- 15V DC) and pulse line on separate wires

### Digital input

- “Hold” signal
- by external contact closing

### Digital output

- 3 relay contacts for:
  - collective fault message
  - limit value max
  - limit value min
  - Load:
  - Max. 250VAC / 2A non-inductive

### Attainable Accuracy

- ± 0.1 % depending on application

### Parameters

- set up via code numbers

### Operation

- by means of 6 push buttons

### Display

- max. 5 digits

### Right to implement technical improvements and/or changes without prior notice reserved.

### Detectors: General Data

<table>
<thead>
<tr>
<th>Counter tube</th>
<th>³He counter tube automatic drift stabilisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating temp.</td>
<td>-20 ... +50°C (-4 ... 122 °F)</td>
</tr>
<tr>
<td>Storage temperature</td>
<td>-40 ... +70°C (-40 ... 158 °F)</td>
</tr>
<tr>
<td>Housing</td>
<td>made of stainless steel</td>
</tr>
<tr>
<td>Cable</td>
<td>7 x 1.5 mm², shielded max. cable length: 1400 m</td>
</tr>
</tbody>
</table>

### Moisture Bunker Probe LB 6666

<table>
<thead>
<tr>
<th>Types</th>
<th>LB 6666-1, 3.7GBq (100 mCi) AmBe</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LB 6666-2, 11.1GBq (300 mCi) AmBe</td>
</tr>
<tr>
<td>Protection class</td>
<td>IP 65</td>
</tr>
</tbody>
</table>

### Moisture Bunker Probe LB 6669

<table>
<thead>
<tr>
<th>Types</th>
<th>Counter tube and preampl. separate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LB 6669-1, 3.7GBq (100 mCi) AmBe</td>
</tr>
<tr>
<td></td>
<td>LB 6669-2, 11.1GBq (300 mCi) AmBe</td>
</tr>
<tr>
<td>Preampifier</td>
<td>LB 2018</td>
</tr>
<tr>
<td>Protection class</td>
<td>IP 65</td>
</tr>
</tbody>
</table>

### Surface Moisture Measurement LB 7410

- LB 7410-13: Lockable surface neutron shielding with 2 counter tubes
- Housing made of stainless steel
- Weight: approx. 50 kg
- LB 7410-14: same as LB 7410-11 but with pneumatic shutter, weight: approx. 55 kg
- LB 7410-55: fire-proof version, weight: appr.90 kg
- LB 7410-66: same as LB 7410-44, but with pneumatic shutter, weight: approx. 95 kg
- Source for LB 7410: 3.7GBq (100 mCi) AmBe 11.1GBq (300 mCi) AmBe

### Density Compensation for Transmission

- Detector: Sz5 D1 50/50
- Scintillation counter, crystal 50x50
- Source: Cs-137 or Co-60 (depending on application)
- Shielding: LB 7440 or LB 7442

### Density Compensation for Backscattering

- Detector: SZ AR 1 44x5
- Scintillation counter, crystal 44x5
- Source: Cs-137, 1.11 GBq (30 mCi)
- Backscatter chamber: Lockable shielding with housing made of stainless steel