

Item number 211921GM:

## In-soil Adapter for GMP220 Series Probes

Since the Vaisala CARBOCAP® Carbon Dioxide Probes Series GMP220 cannot be submerged in water, special precaution must be taken when burying the probes below-ground. The in-soil adapter 211921GM is an open-end adapter for vertical positioning of the probes in below-ground CO<sub>2</sub> profile measurements. In order to ensure reliable performance it is essential to use the in-soil adapters according to the following instructions.

### Structure and operating principle of the adapter

The adapter is built from two parts, the body and the nut providing the attachment to the GMP220 Series Probe. An O-ring is used between the two parts to seal the probe body against the adapter as tightly as possible. The adapter is slightly cone shaped to allow easy installation into the ground (see Figure 1).

When the adapter is mounted on the probe and vertically installed into soil, a "diving bell" type of air pocket is formed around the probe. In case the installation is made correctly, the air pocket will keep the probe dry despite that the soil becomes so wet that this otherwise would destroy the probe. Although it is desirable to keep the volume of this air pocket as small as possible, it is important to ensure

- that the air pocket is deep enough to keep the CO<sub>2</sub> probe dry and
- that convection can occur around the diffusion aspirated probe

The plastic structure keeps the heat conduction through the in-soil adapter and probe at a minimum. The open end at the bottom of the adapter provides a distinct surface for gas diffusion.



Figure 1. The structure of the in-soil adapter and a GMP222 probe.

### Inserting the Probe into the Adapter

Before mounting, disassemble the in-soil adapter. For better protection a layer of sealant (e.g. a vacuum grease) can be used on the O-ring. When mounting the adapter on the probe, ensure that the O-ring will tighten against a smooth part of the probe surface (**Warning: If the O-ring is installed too close to the filter cap or on the calibration or serial number labels, an air tight seal will not be achieved**). The lower edge of the adapter tube must be at about 15 mm below the probe end in order to avoid water reaching the probe. In order to minimize the internal volume when using the shorter GMP221 probe, the length of the adapter can be adjusted by sawing the adapter at the groove marking on its body. After sawing, the corners should be rounded in order to avoid sharp edges (see Figure 2).



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Figure 2. The GMP221 probe (left) and a GMP222 probe (right) inserted into the in-soil adapter

## Installing the Probe with Adapter in Soil

When installing the CO<sub>2</sub> probe and the in-soil adapter into soil it is important to minimize their effects on the soil texture. Depending on the type of soil, a drill could be used to make a hole that is as distinct as possible. Special care should be taken to avoid soil penetrating into the air pocket where the probe is located, otherwise water might reach the probe through the soil. Ensure also that the nut on the probe cable is well tightened.



Figure 3. Three GMP222's in soil CO<sub>2</sub> profile measurements

Note that the vertical probe installation might have an impact on the microclimate below ground due to heat conduction and water penetration along the probe and the In-soil adapter. This and possible air leakage impact the CO<sub>2</sub> concentration. When installing the probe and adapter into soil, the hole should therefore be as small as possible, to avoid making unintentionally large conduits for water.

In some cases a brick or collar could be used in order to avoid the water penetration into the hole.

Figure 3 illustrates a vertical installation of three GMP222's below ground. In case there is a risk that also the connectors could be submerged some vacuum grease could also be applied on the connector threads.

## Temperature compensation

As NDIR based CO<sub>2</sub> measurements are dependent on the ambient temperature and pressure (mainly in accordance with the ideal gas law), compensations must be made in cases when best possible accuracy is required from the CO<sub>2</sub> measurement. It is therefore recommended to measure the temperature at the same depth as CO<sub>2</sub> is measured so that the CO<sub>2</sub> measurement data can afterwards be corrected. Information on the barometric pressure can be obtained from a barometer or the local weather service.

The effect of temperature and pressure can be eliminated by applying correction using the ideal gas law:

$$CVC = UCR \times \frac{1013 \times (t + 273)}{298 \times p} \quad \text{where}$$

$CVC$  = corrected volume concentration (ppm or % CO<sub>2</sub>),

$UCR$  = uncorrected reading,

$p$  = ambient pressure in hPa (= hPa) and

$t$  = ambient temperature (°C)

## Operating Conditions

The GMP220 Series probes are specified for an operating humidity range of 0...100%RH, non-condensing conditions. Therefore, as the soil often is very wet, precaution must be taken in order to avoid condensation on the NDIR sensor and the sensor electronic parts. This can be done by careful installation of the probe and adapter in soil as well as by ensuring the probes are powered on all the time.

### Warning

If the probes are used outside the specifications the warranty will be void. Also any modifications or changes of the product as well as any adding to it without Vaisala's prior authorization will void the warranty.