Rhizon soil moisture samplers

Manual

Meet the difference

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On these operating instructions

☞ **If the text follows a mark (as shown on the left),this means that an important instruction follows.**

⚠ **If the text follows a mark (as shown on the left),this means that an important warning follows relating to danger to the user or damage to the apparatus.The user is always responsible for its own personal protection.**

Text **Italic indicated text indicates that the text concerned appears in writing on the instrument.**

1. Technical description

The Rhizon soil moisture sampler is new and easy to use sampler. Rhizon soil moisture samplers are an alternative for sampling soil moisture with ceramic cups (Rhizon Soil Moisture Samplers = Rhizon SMS).

Advantages of the Rhizon SMS compared with the ceramic cups:

- Small diameter, 2.5 mm.
- Low dead volume, 0.5 ml.
- No ion-exchange properties.
- Available as complete system.
- Competitive price

The standard Rhizon SMS (see figure 1) consist of a 10 cm porous polymer tube connected to a 10 cm PVC tube and a Luer-Lock (L-L) male connector. With each Rhizon SMS a cap is supplied to protect the L-L connector from dirt etc.

☞ **Remove protective cap before use.**

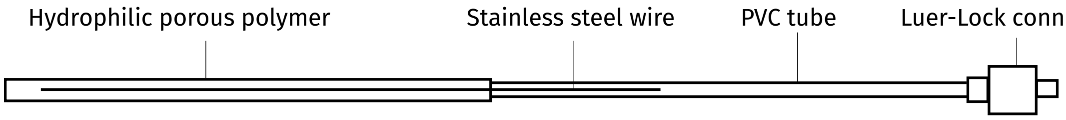


Figure 1: Rhizon soil moisture sampler

The porous polymer (and 5 cm of the PVC tube) is strenghtened by a 15 cm stainless steel wire. The stainless steel wire is connected to the end of the porous polymer. A sample is obtained by connecting a vacuum tube (or a vacuum produced by a syringe).

1.1 Technical specifications

- Bubble point > 2 bar (0.2 MPa).
- Yield in water: 1 bar pressure differential: > 1 ml/min. With a 10 ml vacuum tube the yield in soil is typically 7 ml in 1-16 hours (overnight), depending on soil properties.
- Diameter of the porous tube is 2.5 x 1.5 mm.
- Diameter of the PVC tube is 2.7 x 1.0 mm.
- Volume of the lumen 0.2 ml, total dead volume 0.5 ml.
- Acceptable pH: 3 - 12, also depends on corrosive properties of the soil solution.
- Life expectation 6 months

2. Applications

Rhizon SMS replace ceramic cups for direct extraction of soil moisture from soil. Ceramic cups are strong, but have some disadvantages:

- Bulky, a problem in pots and soil cylinders (less a problem in field research).
- High dead volume.
- Exchange of (divalent) Cations and Phosphate.

A description of the problems to be expected when sampling soil moisture with an emphasis on sampling with ceramic cups is given in: J. Grossmann and P. Udluft, The extraction of soil water by the suction-cup method: a review. Journal of Soil Science, 1991, 42, 83-93.

Rhizon SMS are designed for pot-, cylinder- and column research. Sampling by Rhizon SMS is appropriate when succesive soil moisture samples are needed from the same volume of soil, as in:

- Models of nutrient uptake using the actual concentration of nutrient in the soil solution. When needed the relation between the concentration in the soil solution and quantity absorbed on the exchange complex is estimated by augering an extraction or with a speciation model as Geochem or Charon.
- Mineralisation studies.
- Salt accumulation studies.

Rhizon SMS are preferably inserted horizontally in wet soil. The water acts as a lubricant. Wet soil will set after the (small) disturbance caused by inserting the sampler. Soil-sampler contact will improve after setting and consequently time needed to extract a given volume will decrease.
Use of Rhizon SMS in field soils is possible, but samplers have to be inserted from trenches. Trenches disturb the hydraulic properties of the soil. As a result concentrations of mobile nutrients may differ from those in undisturbed soil, due to differing soil water conditions. Less mobile elements may be sampled correctly from trenches.

An alternative for trenches are manholes produced from PVC tube (see figure 2), this solution is especially suited for forestry. The hole can be augered with an Edelman auger.
A stainless steel postioning system is available (or is very simple to produce) for use in very soft soils (muds, paddy- fields), accuracy of positioning 1-2 cm (see figure 3). Use of the Rhizon SMS is not limited to these situations, Rhizon SMS can also be used for sampling of (waste) water and filtrations of water samples.

An extension PVC tube with silicone connection tubing (art. no. 192113) can be delivered for field research. Special designs can be supplied at request. The stainless steel strengthening wire can be replaced by a nylon wire. The Rhizon SMS with nylon wire is suited for application in disturbed soil samples and in loose compost or peat.

Rhizon SMS will function when the soil is not to dry, suction less than 200-500 hPa. When a soil dries, Rhizon SMS will stop functioning, but will function again after rewetting. Cracking soils may damage the samplers. To control the results obtained with the Rhizon SMS, methods using centrifuging of soil solution are preferred. This reference method is slow but excellent for comparison.

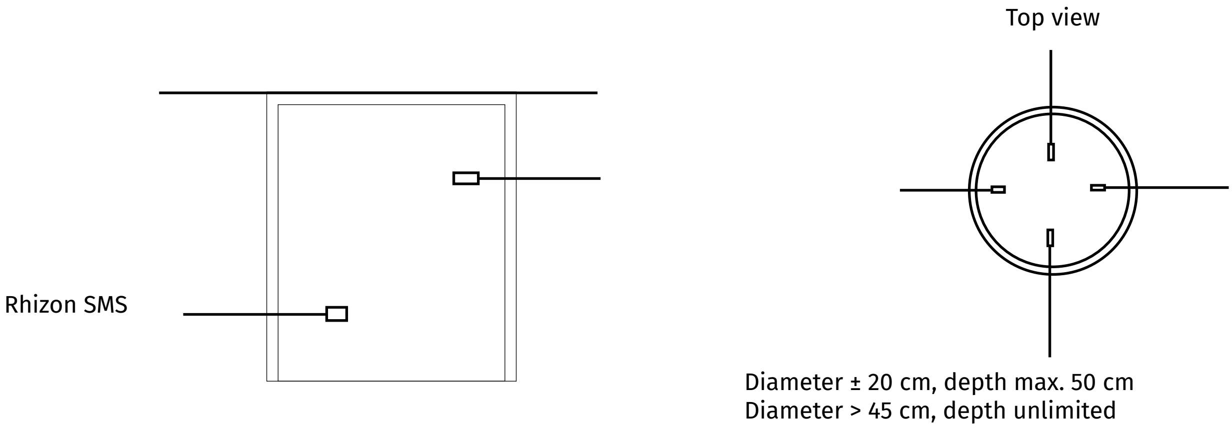


Figure 2: Rhizon SMS in PVC casing

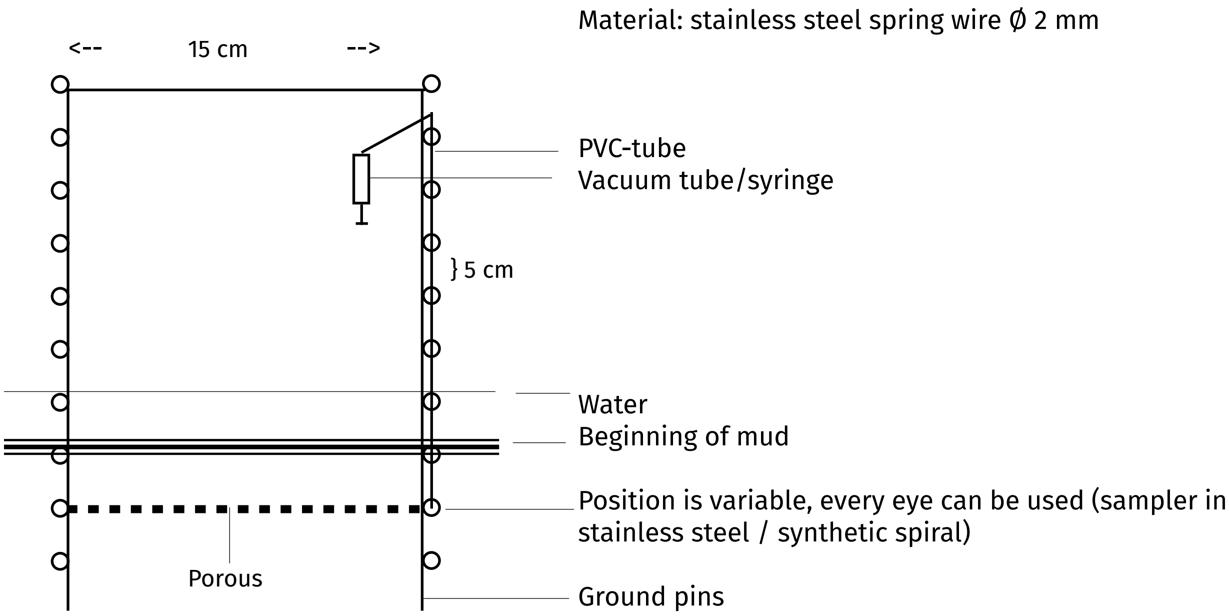


Figure 3: Positioning in very soft soils

3. Instructions for use of the Rhizon SMS

3.1 Inserting the Rhizon SMS in (undisturbed) soil columns

☞ **We are pleased to inform you about various methods of taking undisturbed soil columns.**

Samplers should be inserted in wet soil, because of the limited mechanical strength of the porous material.

Equipment needed:
-Electric or hand drill (+ depth control).
-Drill 3.8 mm.
-Stainless steel rod, diameter 2.0-2.5 mm, pointed (eg. knitting needle)+ depth control (mark with PVC tape).
-2 x L-L connector female + Syringe 10 ml (art. no. 192104).
-Aluminium line level.
-Water and light resistant marker.
-Black PE tube (for drip irrigation etc) 6 x 4 mm, to shield the Rhizon SMS from light to reduce/prevent growth of algae.

3.1.1 Preparation of the pot/cylinder

1. Determine sampler depth from the soil surface, mark positions. When two or more samplers are to be used in one pot, insert samplers shifted horizontally at least 10 cm, use a jig. Drill a hole 3.8 mm about 1 cm deep in the soil. The PVC tube will stop at this position, when the sampler is inserted.
2. Push the 2.0-2.5 mm rod 12 cm in the soil, use a level. When contacting stones: make another hole.
3. In loose soil and peat (2) may not be needed.
4. In the field rodents and insects may damage the microporous and PVC tube, PE is suitable in protecting for insects but not for rodents.
5. Insert the Rhizon SMS through the wall of the pot in packed soil after setting (or put the sampler in the soil with the connection at the surface and fill the pot).

3.1.2 Preparation of the Rhizon SMS: control and inserting

1. Cutt off a piece of PE (length = 2 cm shorter than the PVC tube). Slip the PE tube over the PVC tube until the connector (protection and to prevent growth of algae).
2. Use a thumb nail to squeeze the PVC tube thightly to the stainless steel wire and push the sampler smoothly in the soil. Push until 1 cm of PVC tube is also in the soil. In this way the microporous material will be all surrounded with soil. When the resistance increases suddenly, stop pushing and use an other position. A decrease in resistance indicates a void, also use an other position. Check the yield of the Rhizon SMS with the aid of a vacuum tube or syringe with connector. When 10% of the Rhizon SMS have low yield, replace these samplers or wait some days. When many Rhizon SMS yield no water wait some days. Some days after inserting, as a rule, more samplers will yield water then directly after inserting because the soil sets, consequently soil-sampler contact improves in time.
3. When yield = 0, also some days after inserting, increase the water content of the soil to a suction head of about 20 cm. In loose soil, yield may improve by increasing the soil density.
4. Protect the L-L connector with the protecting cap. Capping prevents soiling and blocking by small animals.
5. When the microporous material of the sampler contacts atmosphere the concentration of salts will increase as a result of evaporation of the water.
6. Holes in cylinder walls which are not used may be blocked with PVC tape.
7. Take care that a connector never is lower than the bottom of a cylinder or pot, otherwise water loss may occur by siphoning.
8. Rats may damage samplers in the field. Protect samplers in field experiments not with PE but with hard PVC tube, PVC electricity pipe will do. Make an incision 2 mm wide at one end to fix the connector. Close the top with a stopper or cap against insects.

3.2 How to use vacuum tubes

Number sample positions and vacuum tubes before sampling. Check the shelf life of the vacuum tubes.
1. Replace the protective cap by a needle with L-L connector.
2. Jab the needle in the vacuum tube.
3. Wait 1 hour or more, when sample volume is adequate stop sampling.
4. Note down samplers with low/no yield.
5. Wait twice as long and repeat 4.
6. Compare volume and time of sampling.
7. Replace Rhizon SMS with yield equal to zero
8. Recap Rhizon SMS with the protective cap.
9. Store samples dark and cooled.
10. Septums of non-siliconised glass tubes are sometimes treated with glycerin. Glycerin may influence nitrate concentrations during storage and will influence the results of (soluble) organic matter determinations.

3.3 Sampling with Rhizon SMS and vacuum tubes

A 10 ml vacuum tube will yield 7 ml in wet soil. The time needed for sampling depends directly of the actual (unsaturated) hydraulic conductivity (k) of a soil. Sampling should be no problem when k > 10^{-3} m/day and fair sampler-soil contact. A problem is that k is a function of water content to a high power (eg. 3-10). A small change in water content may cause the difference between no sample and a sample in a few hours! When the soil dries a sampler may stop functioning, when the soil wets again, the sampler will also wet again and start functioning again. When water suction in a soil is > 500 hPa the pressure differential becomes low and “k” as a rule becomes too low, probably no sample will be obtained.

3.3.1 Volume extracted/Zone of influence

A Rhizon SMS with 10 cm porous polymer with a 7 ml sample, removes a water filled cylinder of 1 cm diameter. With 25 volume % water in a soil, all water in a 2 cm diameter soil cylinder is removed by a 7 ml sample.
The following calculations clarify that samplers can be inserted at 10 cm intervals, but that intervals of 5 cm are less desirable.
Water is removed from a soil cylinder + 2 semi spheres with Length = diameter = 10 cm and 25% water. Contents of the cylinder = $\pi r^2 \times L = 758\ cm^3$

Contents of 2 semi spheres = approx. contents of a ball Contents ball = $4/3\pi r^3 = 523\ cm^3$

Total contents approx. 1.3 l, 25% of which is water = 0.325 l.

So a 7 ml sample contains 2% of the total water amount in a 5 cm wide zone around a sampler, the volumetric water content in this zone is reduced 0.5 volume % by sampling once.

In the calculations is assumed that the hydraulic conductivity “k” has no spatial variability. In real situations the hydraulic conductivity “k” will be variable. The actual zone of influence in a real soil will probably be more spherical, have an irregular shape with the statistical mean shape of a sphere, which envelopes (part of) the sampler.

When plants are growing in the soil they will reduce the water content of the soil. As a rule the plant roots absorb different amounts of water at different positions. So k, the hydraulic conductivity will be variable as well. Samplers will absorb water from sites with relatively high conductivity. So, samplers with 50 cm porous material will probably obtain samples from positions with relatively low or no water uptake by roots and not a more averaged sample then 5 standard Rhizon SMS with 10 cm porous material. It is expected that the mixed sample of 5 standard Rhizon SMS gives more reliable results than 1 of 50 cm, especially when the EC of each sample is determined before mixing.

3.4 Properties of soil moisture samples obtained with Rhizon SMS

Modern analytical methods as a rule need 1 ml sample or less, so the 7 ml to be obtained with a 10 ml vacuum tube is as a rule enough for several determinations because the samples is already filtered.The microporous material is impermeable for bacteria, so samples are sterile, but bacteria and algae may enter the sampler from the connector. Nitrate reduction or ammonia oxydation is improbable but without additives these processes cannot be excluded.

Samples can be preserved with a 1:1 solution with 2 NKCl and cooled storage for nitrate, ammonia and total N determinations. Preferably the samples are analysed shortly after sampling.
Samples of reduced soils will discolor in the vacuum tubes because there is always oxygen present in a vacuum tube due to diffusion. Samples of (partially) reduced soil water to be analysed for Fe, Mn and PO^{-4} should be acidified, pH < 2, and not be filtered before subsampling for chemical analysis. Otherwise gross errors are possible with these determinations. The precaution of acidifying samples before subsampling is also important with elements that (co-)precipitate with Fe, Mn and PO^{-4}.

3.4.1 pH of samples

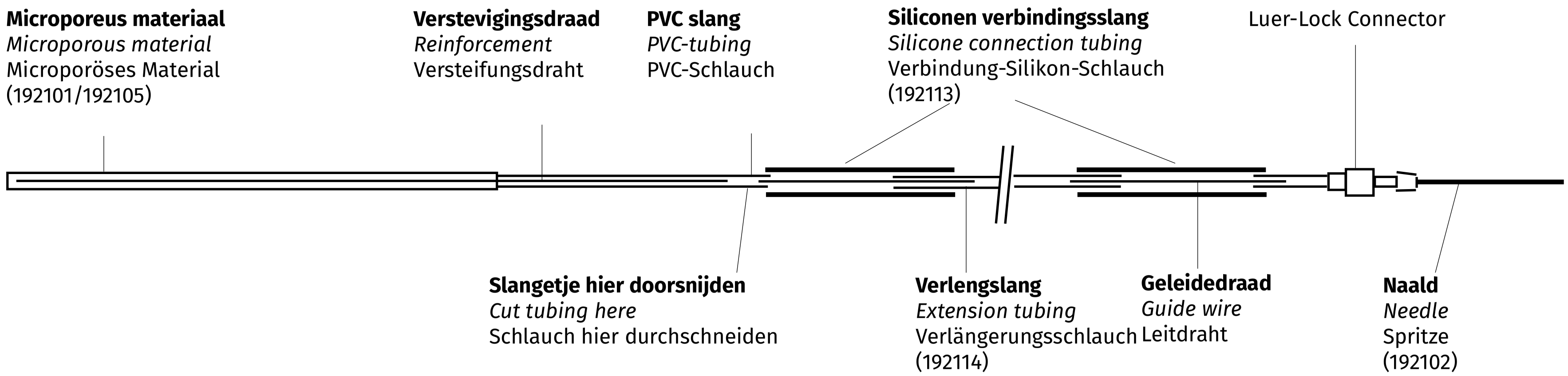
The solid material of the microporous tube is, as most solid materials, little permeable for gas, but the water fraction in the microporous material has the diffusion properties of water. Caused by the difference in pressure over the microporous tube a diffusion flux of soil gas in the water phase of the microporous tube to the lumen of the sampler wil occur.
Loss of carbon dioxide is excluded with vacuum tubes, oversampling of carbon dioxide is not easily estimated because oversampling also depends on the time needed for sampling.

In the vacuum tube sampled water and gas are in equilibrium so pH measurements in samples are expected to be quite reliable. Reliability of pH measurements can be increased by sampling the head space of the vacuum tube, analysing for CO_2 and followed by a pH measurement under a controlled atmosphere.

3.4.2 Organic materials in samples

The samplers are produced from organic materials, so the sampler may add some organic matter to a sample. The microporous tube has no known extractables. PVC tubes contains a plasticizer and stabilizers. Producers of PVC tubes do not give information on the specific additives used by them.
Wether PVC additives give problems in analytical methods has to be determined for each lot. Other tube materials can be a better choice, but your knowledge of interferences due to additives in plastics is essential in selecting a tube material for a specific application.
Decaying organic material may influence $N\text{-}NH_4$ analysis in auto-analyser systems.

Hoe de Rhizon SMS voorzien van een verlengslang
How to fit Rhizon SMS with an extension tubing
Wie wird eine Verlängerungsschlauch an einem Rhizon SMS befestigt



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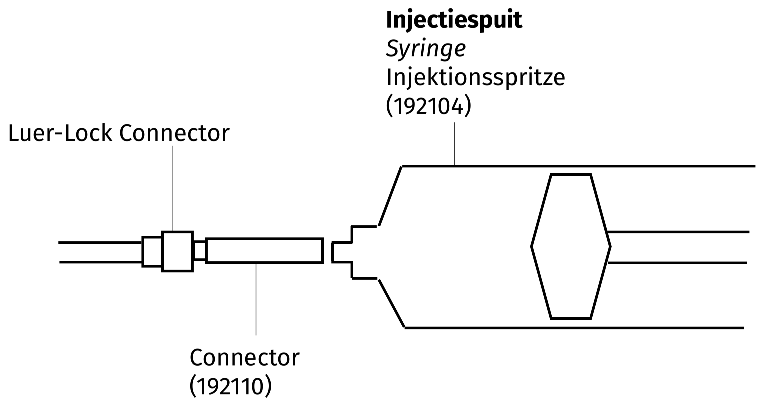

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