# User Manual

# SK20

**Pore water sampler (suction cup)**


Art. No. SK20
Version 12/2008
Authors: ge/tk/ma

# Content

# 1 SK20

## 1.1 Safety instructions and warnings

Please pay attention to the following possible causes of risk:

- Caution! Use only implosion-proof sampling bottles. Danger of injury!
- The ceramic cup is fragile. Excessive load, bending or force can lead to the break.
- Never touch the ceramic cup. Grease, oil or sweat will disturb the quality.

## 1.2 Content of delivery

The delivery of a SK20 includes:

- SK20 pore water sampler with suction tube (standard tube length 5 m) inside reinforced protection tube

## 1.3 Foreword

Measuring systems must be reliable and durable and should require a minimum of maintenance to achieve target-oriented results and keep the servicing low. Moreover, the success of any technical system is directly depending on a correct operation.
At the beginning of a measuring task or research project the target, all effective values and the surrounding conditions must be defined. This leads to the demands for the scientific and technical project management which describes all quality related processes and decides on the used methods, the technical and measurement tools, the verification of the results and the modelling.
The continuously optimized correlation of all segments and it's quality assurance are finally decisive for the success of a project.
So please do not hesitate to contact us for further support and information. We wish you good success with your projects.
Yours,
Georg von Unold

## 1.4 Intended Use

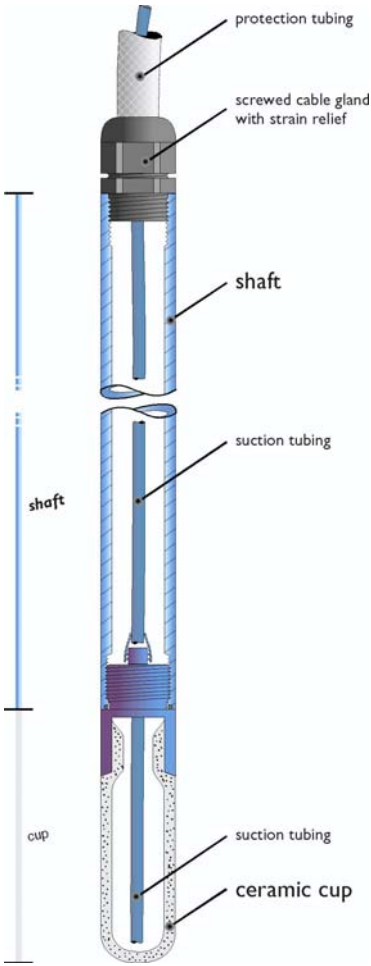
Pore water samplers are designed to extract soil water from saturated and non saturated soils. To extract a soil water solution, a negative pressure has to be applied. The cups are made of a special ceramic with constant and defined pore distribution with small chemical activity and adsorption.

## 1.5 Guarantee

UMS gives a guarantee of 12 months against defects in manufacture or materials used. The guarantee does not cover damage through misuse or inexpert servicing or circumstances beyond our control. The guarantee includes substitution or repair and package but excludes shipping expenses. Please contact UMS or our representative before returning equipment. Place of fulfilment is Munich, Gmunder Str. 37!

# 2 Description of the sampler

## 2.1 Construction



## 2.2 The ceramic cup

The cup consists of 70% porous $Al_2O_3$ and about 30% $SiO_2$ sinter material. The special manufacturing process guarantees homogeneous porosity with good water conductivity and very high firmness. Compared to conventional porous ceramic the cup is much more durable.
The bubble point is higher than 2 bar.

The cup has been tested by the Technical University Munich, Center of Life and Food Sciences Weihenstephan, department forest nutrition and water balance. The applied test procedure has been proposed to the DIN-NORM committee NAW12/UA5/AK4 for implementation as a DIN standard.

Suitability as been approved for:
✓ Nitrate ✓ Chloride ✓ Sulphate ✓ Calcium
✓ Sodium ✓ Magnesium ✓ DOC

It is not suitable for:
✖ Heavy metals and Aluminium
(see chapter “Scientific background”)

Before first use treat the cup as described in chapter “Rinsing”.

## 2.3 Acrylic glass shaft

With the shaft it is possible to install the sampler in the required depth. The shaft consists of an extremely resistant Acrylic material with highest durability against bending, scratches, breakage.

## 2.4 Suction tube

The suction tube is made of polyethylene, outer diameter is 2.8 mm and the inner diameter 1.6 mm. Normally the suction tube is connected to a sampling bottle with vacuum.

## 2.5 Protection tube

The reinforced protection tube prevents that the suction tube is bended or damaged by rodent bite.

# 3 Installation and operation

## 3.1 Rinsing

Always rinse each ceramic cup or plate with 500 to 2000 ml de-ionised water, and then condition them with the adequate soil water solution.
If there is enough time before the first samples should be analyzed you can do without rinsing and then discard the samples from the first week, or at least 1000 ml.
It might be considerable to discard an amount of 500 to 2000 ml of your first won samples.

When charged with high amounts of acidity sintered ceramic materials corrode and release Aluminium. Therefore, we strictly oppose to rinse the ceramics with acid solution, although this is recommended in some literature.

- We do not recommend to rinse the cup with hydrochloric acid as this might destruct the cup. This will breach the warranty!
- Before installation it is recommendable to immerse ceramic cups in de-ionised water for some time, preferably over night, so the pores will be water saturated.

## 3.2 Installation

### 3.2.1 Auger

The ceramic cup has to have a good capillary contact to the soil matrix. Therefore, the ceramic cup should fit into the drilling as tight as possible. To achieve this, the auger tip should exactly have the same diameter as the cup.
The shaft itself should have a space of 1 to 2 mm for easy insertion, low disturbance and possibility to control the fitting of the cup.

UMS offers the special gouge auger **TB-20** with a tapered tip as an accessory. This auger has a diameter of 20 mm on the first 5 cm of the tip, and 22 mm on the further section.

### 3.2.2 Slurrying the cup

It is only recommendable to slurry the ceramic cup in a highly sandy or stony soil. Slurry the cup with a paste made of the soil taken from the bottom of the augered hole. Optionally you may use washed quartz sand (mesh size 1200).
Mix a viscous paste with water and fill it into the hole with a properly sized pipe. In horizontal installations blow the paste into the pipe.

Note that fine material might be washed out by heavy drainage water. Then, the cup might lose it's capillary contact to the soil. In this case repeat the slurrying.

Also note that sandy soils drain quickly (see pF/wc curve for sandy soils). Therefore, soil solution can only be extracted with a suction cup at low soil water tension (pF < 2 or unbound water). Sandy soils drier than -10 kPa only have small volumetric content of water as large pores are already vented.

### 3.2.3 Jacket tubes

Specially in coarse sand or pebbly soils it might be necessary to install jacket tubes as a drilled hole collapses before the suction cup is inserted.
If the samplers are installed in jacket tubes ensure that condensed water or leachate is conducted away from the suction cup. In horizontal installation a decline of 3% towards the manhole is suitable.

Note that the jacket tubes should not be installed closer than 50 cm away from the suction cup.
If the jacket tubes are installed with percussion drilling machine the final 100 cm should not be rammed but manually drilled to prevent compaction of the soil.
Beside in compact sand also drilling rockets can be used.

### 3.2.4 Installation angle

The sampler should be installed in a way that the major flow path is not disturbed by the sampler’s shaft.
If for example the flow path is vertical the shaft should be installed with an angle of at least 20° away from the vertical line.

### 3.2.5 Drilling

- Put a mark on the auger to drill to the proper depth.
- Take away the organic layer with a shovel to avoid that the auger pushes organic material into lower layers.
- Drill the hole.

- If required insert the slurry paste into the hole with a pipe. Immediately insert the sampler. In pebbly soils you only have 10 seconds until the slurry paste might drain away.

Do not use force when inserting the shaft. Do not use tools or a hammer.

The SK20 sampler has a black mark on the top end of the shaft. If the shaft is not installed vertically this mark should point upwards - then the opening of the suction tube inside the cup is at the lowest position of the cup.

- In case put pack the organic layer and tighten the soil to close the gap between the shaft and the augered hole.
- Push the supplied rubber surface water retaining disk over the shaft to prevent that surface water runs along the shaft. Optionally the top part of the hole can be sealed with swellable Bentonite pellets.

### 3.2.6 Lay the tubes

Tubes should be buried in a depth of at least 10 cm. If the system should work year round the suction tubes have to be installed in a frost free depth.
UMS supplied samplers have a reinforced protective tube which protects the suction tube. It is recommendable to insert tubes without a protective tube in proper plastic protection tubes.

## 3.3 Assembly and start-up

Insert each suction tube into a sampling bottle. In a discontinuous system attach your vacuum pump to each sampling bottle, create the required vacuum and then lock the bottle.
In an extended vacuum system connect all sampling bottles with vacuum tubes and with your vacuum unit. Start to evacuate the

system. Please refer to the manual of your vacuum unit for instructions.
A vacuum should assemble. If no vacuum is established, check your system for leaks.

With the first won solution the system is flushed. Discard the first samples.

## 3.4 Collecting sampled solution

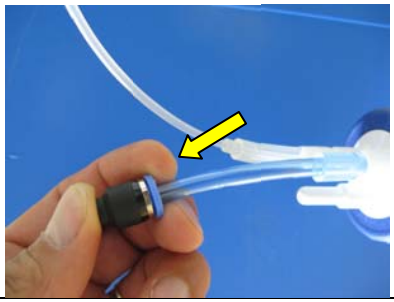
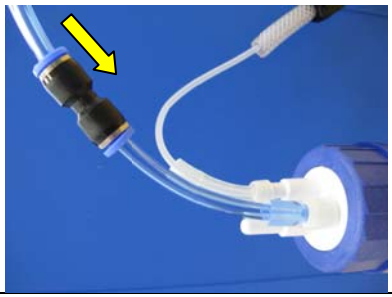
### 3.4.1 Discontinuous method

UMS sampling bottles are either plugged with a clamp or with a fitting as seen the photo.

Open the vacuum tube to vent the bottle. Screw off the cap and collect the sample, or replace the bottle with a clean one.

Put back the bottle cap and evacuate the bottle with your pump. Now bend the vacuum tube to seal it and remove your pump. Reattach the fitting or the clamp.

## Procedure of the discontinuous method

| 1. Take off the plug from the sampling bottle | 2. Connect the vacuum tube from the pump with the connector piece. Evacuate the bottle to the needed vacuum. | 3. Bend the blue tube on the sampling bottle to retain the vacuum when you take off the connector piece. | 4. Immediately put back the plug on the tube of the bottle. Now you can release the short tube. |
|---|---|---|---|
|  |  |  |  |

### 3.4.2 Continuous method

In a system with continuous vacuum, switch off the vacuum unit. Then vent the system. Now collect all samples from the sampling bottles and reassemble the system.
In case check the Tensiometer readings and the sampled amounts and adjust the settings of your vacuum unit.

# 4 Service and maintenance

## 4.1 Empty suction cups before frost

If suction cups should remain installed during periods with temperatures below freezing point, they must be emptied to prevent frost damage. Please note, that in times free of snow but with air temperatures below 0°C, the area of frost declines from the soil surface into deeper soil horizons.

Required tools for emptying: One retaining tube clamp for each suction cup, a syringe (50 ml) and a vacuum pump.

How to proceed:

- With the vacuum pump, completely extract the water left in the suction cup.
- Attach the syringe to the extraction tube. Press 20 ml of air into the cup to achieve a positive pressure of approx. 100 hPa.
- Lock the extraction tube with a tube clamp to keep up the overpressure.

As soon as water inside the extraction tube is frozen, the suction cup cannot be emptied anymore. The ceramic cup might be damaged by the frozen water.

## 4.2 Cleaning and storage

For cleaning, wipe of the shaft with a moist cloth. The suction cups should be stored in a position where a deformation of the shaft is avoided.

Do not touch the ceramic with your fingers.

# 5 Protecting the measuring site

## 5.1 Theft and vandalism

The site should be protected against theft and vandalism as well as against any farming or field work. Therefore, the site should be fenced and signposts could give information about the purpose of the site.

## 5.2 Cable and tube protection

Cables and tubes should be protected against rodents with plastic protection tubes. UMS offers dividable protection tubes as accessory. For long term studies we recommend to dig cables and tubes a few centimetres below soil surface inside protection tubes.

## 5.3 Frost

For all-season operation install suction tubes in a frost-free depth and the sampling bottles in an insulated and buried box.

# 6 Troubleshooting

If no or only a little amount of water is extracted over a longer period of time please check the following:

- If you have an automatic regulation, for example with the VS vacuum station, and the pump repeatedly switches on the reason could be a leak in the system. Check all tubes and connections for tightness.
- Sampling cups have a very small sphere of influence. Depending on their hydraulic contact the sampler either extracts water from the primary pores or, specially in heterogeneous soils, the secondary pores (cracks, macro pores). Therefore, results can turn out variously in extremely heterogeneous soils.
- As water can only be extracted from a moist soil results can be poor during summer or in dry soils.
- Pathways caused by mouse holes or roots quickly conduct water into lower horizons where the water accumulates [Riess 1993].
- Fine particles can clog the ceramic pores over the time. To flush the ceramic while installed will only have a short-lived success as the particles are only moved into the surrounding soil. Clogging should be diminished from the beginning by keeping the flow rate as low and as constant as possible, for example by a tension controlled vacuum. The vacuum should only be as high as required. Test have shown that these measures reduce clogging [Riess 1993].

# 7 Appendix

## 7.1 Technical specifications

| Technical Specifications SK20 | | |
|---|---|---|
| Shaft | Acrylic, ∅ 20 mm | |
| Extraction tube | Polyethylene, ∅ inside 1.6 mm | |
| Protective tube | PVC, with reinforced fabric, ∅ 11 x 5 mm | |
| Cup type | K100 | |
| Cup size | Length 54 mm ± 0,8, diameter 20 mm - 0.5 | |
| Active surface | 34 $cm^2$ ± 1 | |
| Filling volume | 8 ml ± 1 | |
| Cup porosity | 45% ± 2 % | |
| Pore size | 1 µm ± 0.1 µm | |
| Hardness (Mohs) | 7 MH | |
| Flexural strength | 60 $N/mm^2$ ± 0,5 | |
| Compressive strength | 240 $N/mm^2$ ± 10 | |
| Coefficient of elongation | 5.8 x $10^{-6}$ ± 3 | |
| Chemical Compound | $Al_2O_3$ | 70 ± 0,5 % by volume |
| | $SiO_2$ | 29 ± 0,5 % by volume |
| | $R_2O$ | 0,8 ± 0,1 % by volume |

## 7.2 Accessories

| Description | Art. no. |
|---|---|
| Portable vacuum case without regulation, internal pump for max. vacuum -85 kPa (-0.85 bar) or pressure max. 3.5 bar, rechargeable battery 7 Ah, particle filter, gauges for vacuum and pressure, in watertight storm case 30x25x13 cm, 4.8 kg; supplied incl. recharger 230 VAC | **VacuPorter** |
| Please order additionally: Mains recharger 110 VAC ... 230 VAC, for VacuPorter, incl. set of international plug adapters | **vp.110VAC** |
| Hand-operated vacuum floor pump, volume 410 ml per stroke, achievable vacuum 0 … -80 kPa, aluminum body, steel foot, height 57 cm, weight 2 kg, for evacuation of larger volumes | **VPS-2** |

*VacuPorter*

*VPS-2*

*Sampling bottle*

*SF-box*

| | |
|---|---|
| Sampling bottle 500 ml, implosion protected, with screw cap for up to 3 tubes | **SF-500** |
| Sampling bottle 1000 ml, implosion protected, with screw cap for up to 3 tubes | **SF-1000** |
| Sampling bottle 2000 ml, implosion protected, with screw cap for up to 3 tubes | **SF-2000** |
| Spare cap for sampling bottle GL45, blue | **SFK** |
| Clip for wall mounting of sampling bottles | **SF-CLIP** |
| | |
| PVC-box for 6 sampling bottles, L 400 x B 300 x H 350 mm, incl. 6 lead-throughs PG9 | **SF-BOX** |
| Insulated box, dimension outside 600 x 400 x 365 mm, inside 510 x 310 x 300 mm, incl. 14 lead-throughs PG9 for protective tubes | **SF-ISOBOX** |
| Automatic overflow valve for sampling bottles | **SF-Protect** |

*SF-protect*


*VS-pro*


*VS-single*

| **Vacuum systems** | |
|---|---|
| 2-channel vacuum unit for two adjustable vacuum circuits 0...-85 kPa, one controllable with optional Tensiometer T4 or T8, display keypad, Aluminum enclosure 26x16x22cm, IP66, incl. tensioLink connector tL-8/USB-Mini and software tensioVIEW | **VS-pro** |
| 2-channel vacuum system, without display/keypad, adjustable vacuum pump 0… -85 kPa, for two constant vacuum circuits, one controllable with optional Tensiometer T4 or T8, Aluminium enclosure 26x16x22cm, IP66, incl. tensioLINK connector tL-8/USB-Mini and software tensioVIEW | **VS-twin** |
| 1-channel vacuum system, incl. adjustable vacuum pump 0… -85 kPa, for one constant vacuum circuit, controllable with optional Tensiometer T4 or T8, Aluminium enclosure 26x16x22cm, IP66, tensioLINK interface RS485 for external data logger connection | **VS-single** |

*b.TB-20 TBE-100*

| | |
|---|---|
| Special gouge auger, shaped tip for UMS-Tensiometers and UMS-suction cups, diameter 20 mm, length 1250 mm, with hammering head (without elongation) | **b.TB-20** |
| Gouge auger elongation 100 cm for Tensiometer and suction cup augers | **b.TBE-100** |
| | |
| Cable protection tube, inner diam. 8,7 mm, max. cable diam. 4 mm, dividable | **ks.DN-10** |
| Cable protection tube, inner diam. 12,5 mm, max. cable diam. 7 mm, dividable | **ks.DN-14** |
| Cable protection tube, inner diam. 24,2 mm, max. cable diam. 14 mm, dividable | **ks.DN-23** |
| Cable protection tube, inner diam. 30,0 mm, max. cable diam. 18 mm, dividable | **ks.DN-37** |

## 7.3 Glossary

***Suction cup, pore water sampler or lysimeter***
Different terms are common. In this context it is an instrument consisting of a hydrophilic membrane, shaft and suction tube which is used to extract soil water solution from unsaturated zones.
We do not use the term lysimeter for pore water samplers as we define a lysimeter as a monolithic soil column.

***Lysimeter***
Container with defined surface, filled with soil and with at least one outlet. Used for quantification of water and substance flows, decay/reaction processes and simulation.

***Tensiometer***
Instrument for measuring soil water tension.

***Vacuum***
Pressure below atmospheric pressure.

## 7.4 Units

| | pF | hPa | kPa=J/kg | MPa | bar | psi | %rH |
|---|---|---|---|---|---|---|---|
| **Wet** | 1 | -10 | -1 | -0,001 | -0,01 | -0,1450 | 99,9993 |
| | 2,01 | -100 | -10 | -0,01 | -0,1 | -1,4504 | 99,9926 |
| **Field capacity** | 2.53 | -330 | -33 | -0,033 | -0,33 | -4,9145 | 99,9756 |
| **Tensiometer ranges*** | 2.93 | -851 | -85,1 | -0,085 | -0,85 | -12,345 | |
| | 3 | -1.000 | -100 | -0,1 | -1 | -14,504 | 99,9261 |
| | 4 | -10.000 | -1.000 | -1 | -10 | -145,04 | 99,2638 |
| **Permanent wilting point** | 4.18 | -15.136 | -1.513 | -1.5 | -15 | -219,52 | 98,8977 |
| | 5 | -100.000 | -10.000 | -10 | -1 00 | -1.450,4 | 92,8772 |
| **Air-dry**** | 6 | -1.000.000 | -100.000 | -100 | -1 000 | -14.504 | 47,7632 |
| **Oven-dry** | 7 | -10.000.000 | -1.000.000 | -1.000 | -10 000 | -145.038 | 0,0618 |

* standard measuring range of Tensiometers
** depends on air humidity

Note: 1 kPa corresponds to 9,81 cm water column

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# 9 Index

## *W*

# Your addressee at UMS


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