

2E a division of



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# Subject Areas

# Soil



## Subject Areas

## 2E0 Products

Complex processes which can have a negative impact on this habitat take place in the soil. For budding engineers and specialist technicians in the field of environmental engineering, it is therefore necessary to develop an understanding of these processes. The subject areas in the soil area comprise hydrogeology and soil treatment.

### Hydrogeology

In the field of hydrogeology, we offer selected training equipment which will help you to teach the basic hydrogeological processes in soils in a practical and clear manner. Issues such as seepage of precipitation, seepage flows and groundwater flows are studied. Other devices of interest on these and related topics can be found in our catalogue 4b "Hydraulics for Civil Engineering".

### Soil treatment

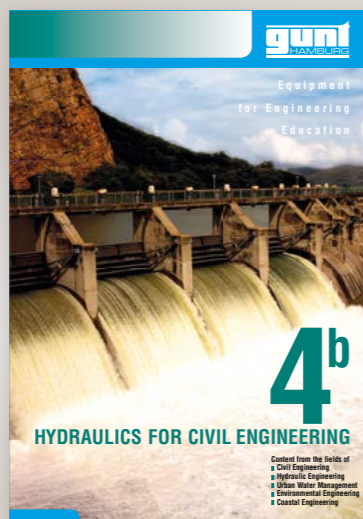
In this subject area you will find selected teaching devices which cover the processes typically used in the treatment of contaminated soils. Most of these processes have their origins in classical process engineering. Our complete range in the field of process engineering can be found in our catalogue 5.

### Hydrogeology

- HM 165**  
Studies in Hydrology
- HM 141**  
Hydrographs after Precipitation
- HM 167**  
Ground Water Flow
- HM 169**  
Visualisation of Seepage Flows

### Soil treatment

- CE 225**  
Hydrocyclone
- CE 630**  
Solid-Liquid Extraction



# Basic Knowledge Hydrogeology



## What is hydrogeology?

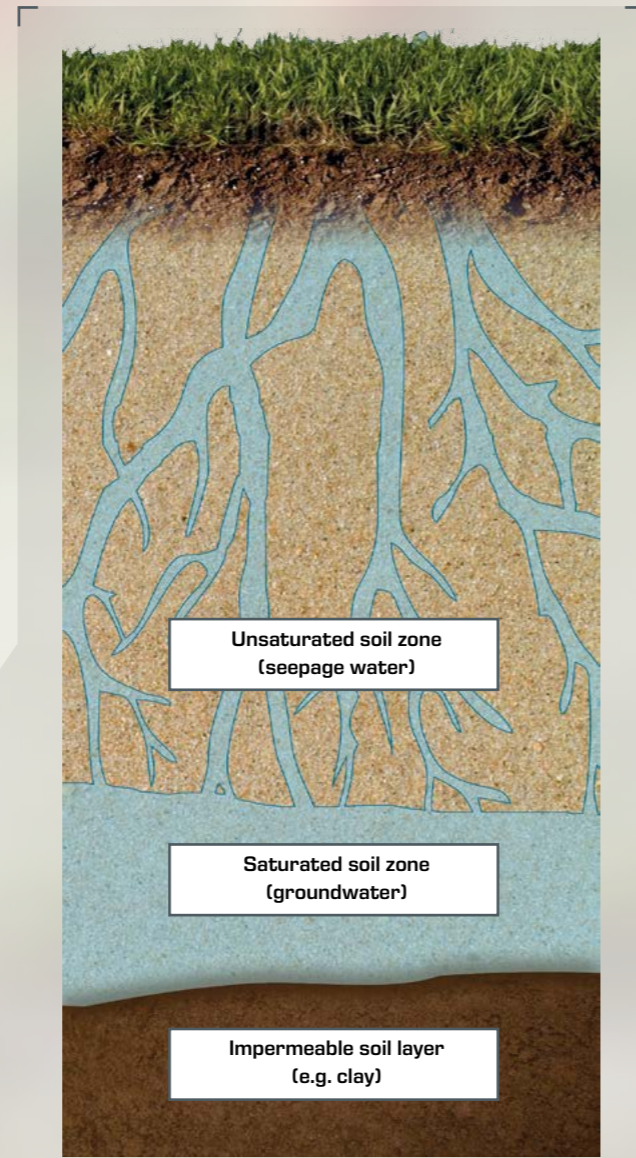
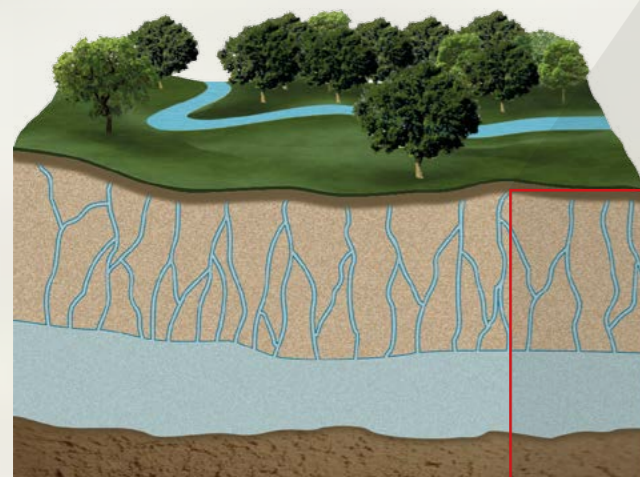
Hydrogeology is an applied discipline of geosciences. Unlike hydrology, which deals with above-ground water, hydrogeology covers all aspects which are related to water contained in the ground. These include the following topics in particular:

- seepage and storage of precipitation
- flow processes in soils (e.g. seepage flows)
- regeneration, flow and pumping of groundwater
- drainage measures
- impact of construction on the hydrogeological conditions in the ground

## Flow processes in soils

Flow processes in soils are of central importance in hydrogeology. Such flow processes take place in different soil layers. We must always distinguish between the unsaturated and saturated soil zones. The upper layer is usually not completely saturated with water, so some pores also contain air. Below this region is a soil zone whose pores are completely filled with water. This zone is therefore also referred to as the saturated soil zone.

Basic knowledge of these topics is necessary, for example in the exploration, evaluation and use of groundwater resources. Other applications include the protection of groundwater through safeguarding and remedial measures and the drainage of precipitation.



## Groundwater: vital reservoir

Groundwater is underground water which fills the pores of the earth's crust and whose possibility for movement is determined solely by the force of gravity. Groundwater fulfils many important functions, for example as a reservoir for drinking water production. Furthermore, an intact groundwater table is an important component of the global water cycle.

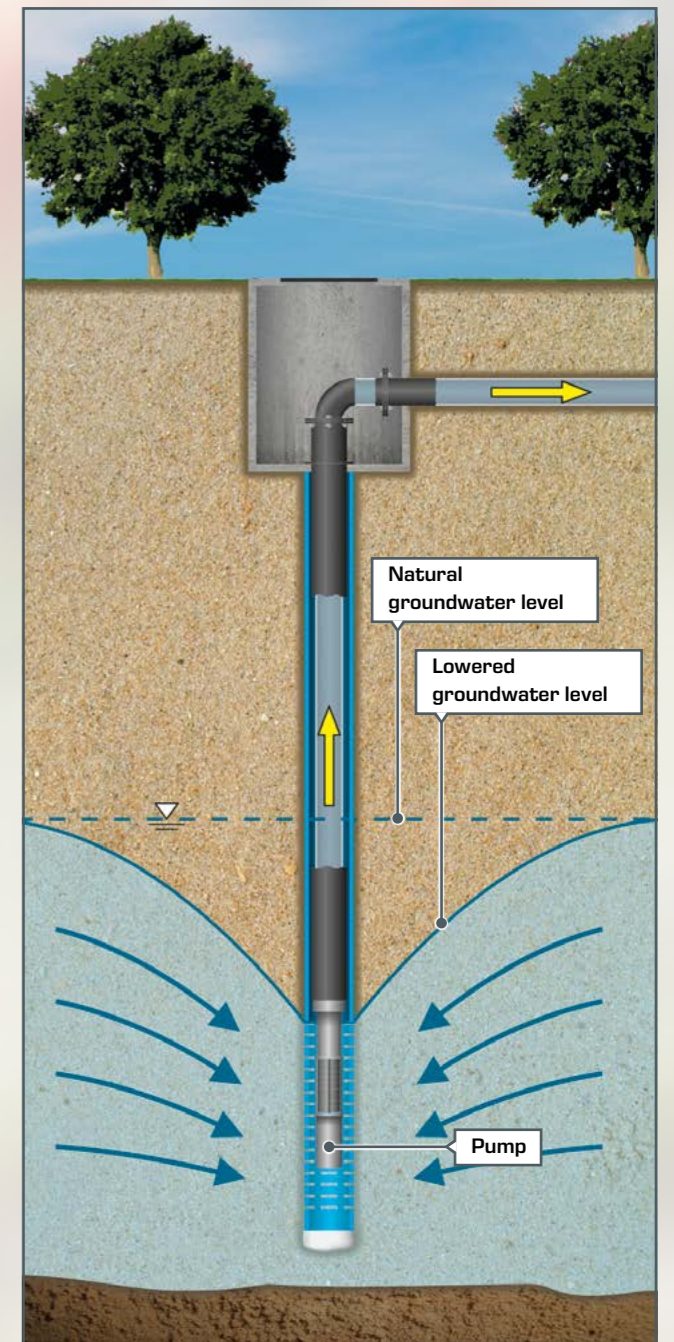
## Interventions in hydrogeology

In the past, the improper handling of chemicals has allowed many toxic substances to enter groundwater. The aim of sustainable environmental engineering is therefore to provide a sustainable use of groundwater whilst largely avoiding the harmful effects on the groundwater table at the same time. Where contaminants have already entered the groundwater, safeguarding or remedying of the affected area is required to prevent further spread of the contamination.

Many structural measures affect hydrogeological conditions in the soil. Therefore such construction projects require solid hydrogeological knowledge and must be planned with great care.

For example, the extraction of groundwater by production wells results in a funnel-shaped lowering of the groundwater level.

In structures where flow passes underneath or through, such as sheet piles and dams, exact knowledge of the course of seepage flows is a crucial factor in the stability of the structures. Such structures must therefore be realised while taking the hydrogeological impact into account.



Depression cone in the extraction of groundwater

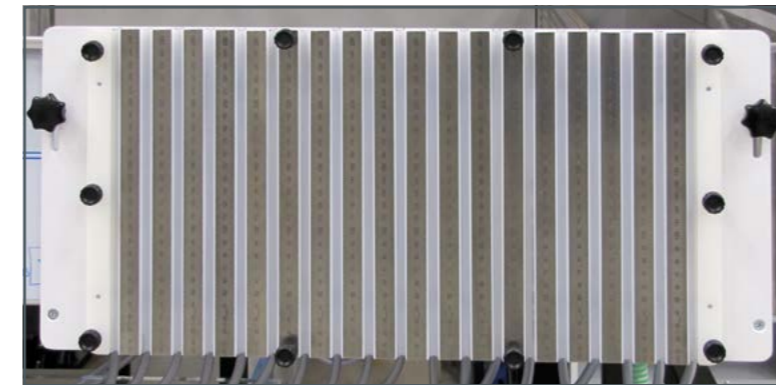
# HM 165 Studies in Hydrology

Hydrological studies are conducted in connection with the design, construction and operation of hydraulic engineering systems and water management functions. These studies focus on topics such as seepage and flow of water in the soil and the use of groundwater resources.

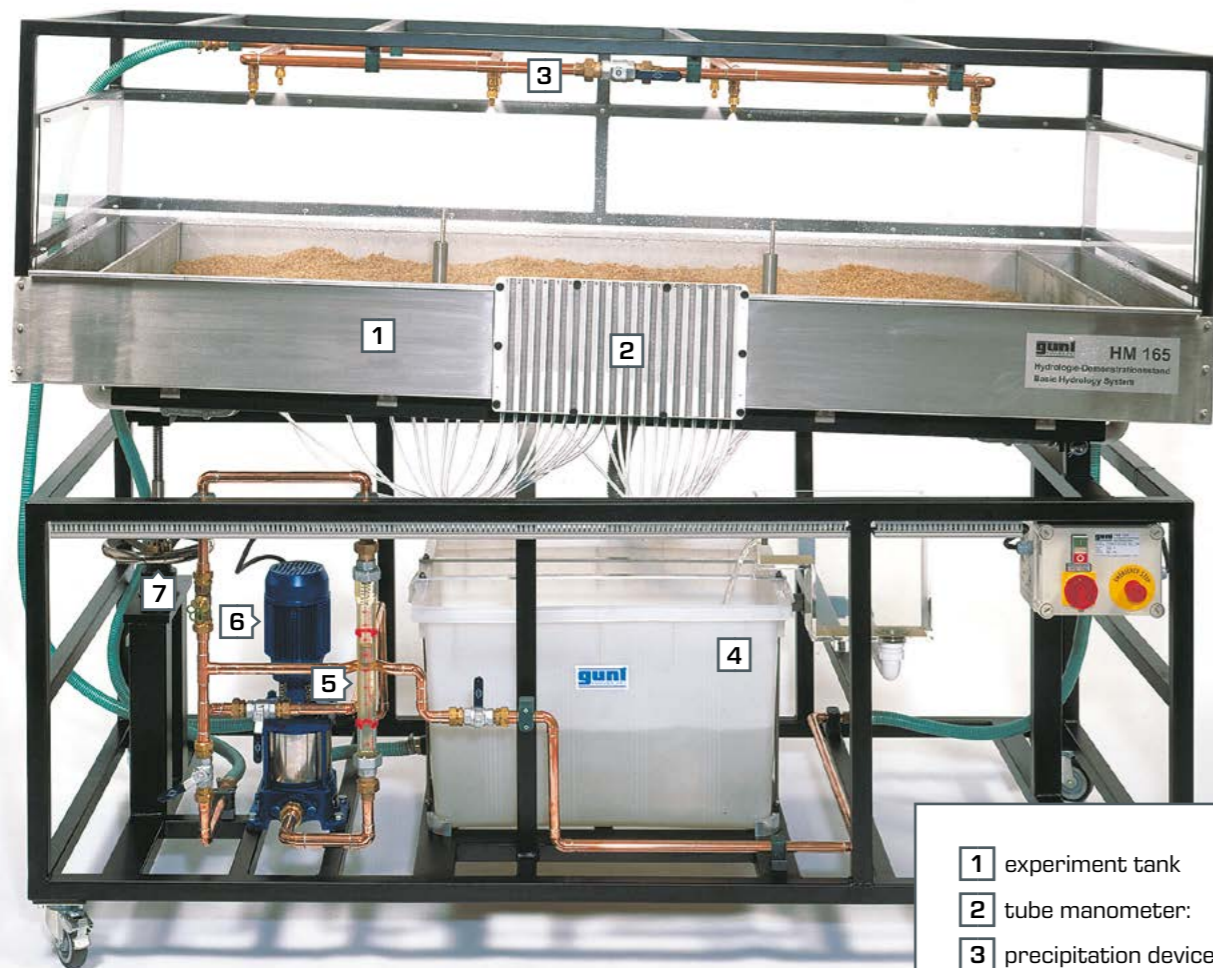
This device can be used to study seepage and groundwater flows after precipitation. In particular, the permeability and storage capacity of soils can easily be observed. Many adjustable parameters allow a wide range of experiments.



Precipitation device with nozzles for realistic simulation of rainfall



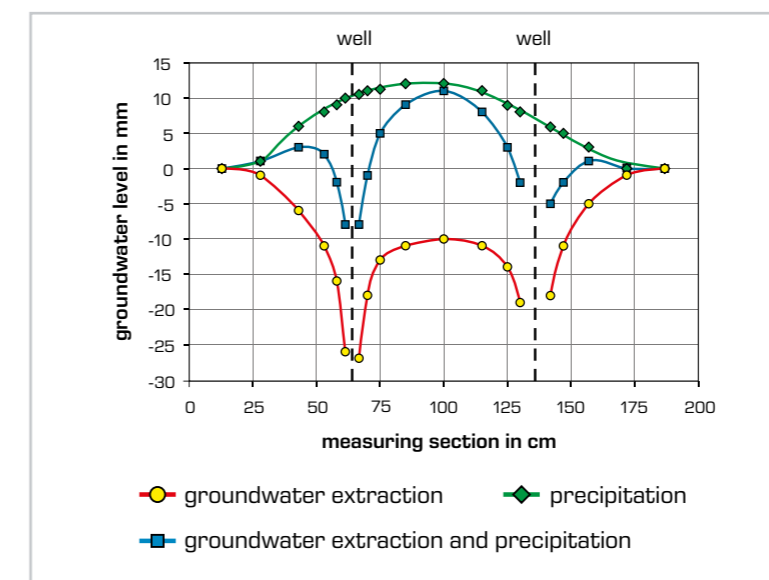
19 tube manometers allow very detailed measurement of the groundwater level.



- 1 experiment tank
- 2 tube manometer:
- 3 precipitation device
- 4 storage tank
- 5 flow meter
- 6 pump
- 7 inclination adjustment

To illustrate groundwater flow, the water is supplied to the experiment tank via two side-mounted chambers. A precipitation device is available for studying precipitation. There are two wells with perforated tubes or two side-mounted chambers with drainage screens available for the investigation of various drainage systems. At the bottom of the experiment tank are 19 connections for measuring groundwater levels which are indicated on tube manometers.

With this device you also receive comprehensive instructional material. A detailed description of selected experiments enables you to quickly incorporate the device into your teaching.



Excerpt from the HM 165 manual: measured island groundwater levels for three different scenarios.



Learning objectives	
■	investigating transient processes <ul style="list-style-type: none"> <li>▶ studying how precipitation of varying duration affects drainage</li> <li>▶ storage capacity of a soil</li> </ul>
■	investigating steady processes <ul style="list-style-type: none"> <li>▶ investigating the seepage flow</li> <li>▶ effect of different soil saturation levels</li> </ul>

Product No.  
070.16500  
More details and technical data:  
[gunt.de/static/s3193\\_1.php](http://gunt.de/static/s3193_1.php)

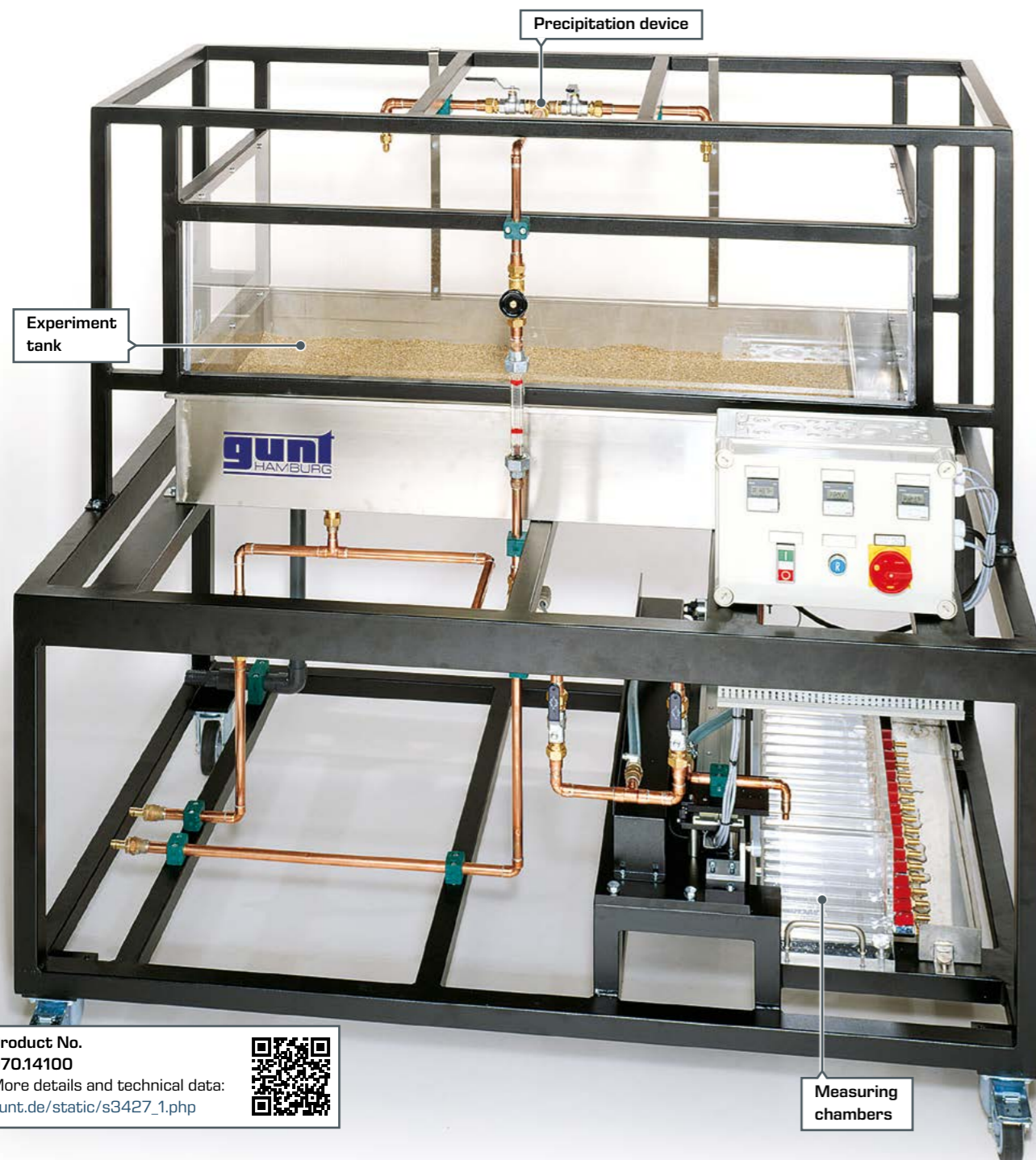


# HM 141 Hydrographs after Precipitation

Hydrographs are an important tool for the representation of hydrological data such as precipitation, groundwater levels or drainage. Furthermore, a hydrograph is the basis for the design of sewer systems. In this case, the progress of the amount of precipitation over time is just as important as the quality of the soil.

## i Hydrograph

A hydrograph is defined as the graphical representation of drainage (for example in  $\text{m}^3/\text{h}$ ) at a particular measuring point as a function of time.



Product No.  
070.14100  
More details and technical data:  
[gunt.de/static/s3427\\_1.php](http://gunt.de/static/s3427_1.php)

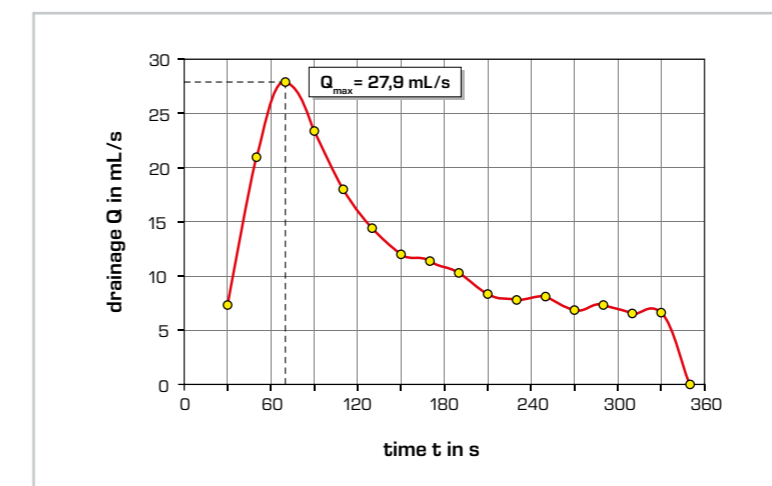


The core element of HM141 is an experiment tank filled with sand or gravel. Using timers, you can apply precipitation to the experiment area with varying duration and intensity. The drainage of the experiment area can be implemented either with a drainage tube or a drainage chamber located at the side of the experiment tank.

The water draining from the experiment tank is filled successively into 17 measurement chambers controlled by time. Determining the amount of water in the individual measurement chambers allows you to determine the timing of drainage from the experiment area, i.e. the hydrograph.



The measuring chambers are filled successively in a time controlled manner.



Excerpt from the HM 141 manual: typical hydrograph curve with drainage via lateral outflow chambers. The maximum drainage occurring in this precipitation event can be determined from the hydrograph.



**Learning objectives**

- effect of precipitation of varying duration or intensity on soils with different saturation
- record hydrographs after precipitation
- storage capacity of soils with different saturation
- compare natural dewatering with dewatering via drainage pipe
- influence of rainwater retention basin on the hydrograph

# HM 167 Ground Water Flow

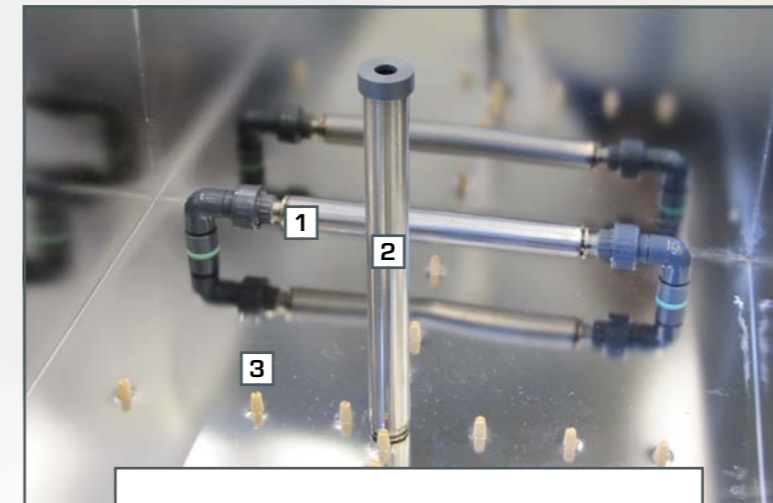
Many structural measures have an impact on the groundwater level. This may be the case for example in usage of groundwater, in flood prevention or in remedial measures. Exact knowledge of the effects of such structures on the groundwater level is therefore an important foundation for planning for environmental engineers.

We have developed our HM 167 device in order to practically teach such issues. The trainer allows you to represent typical structural scenarios and to investigate their influence on the groundwater flow in three dimensions.

The core element of HM 167 is an experiment tank filled with sand or gravel. You can use different models in the experiment tank to simulate structures. The models can be used to study dykes, excavation pits and wells.



Models for installation in the experiment tank



- 1 experiment tank with water supply
- 2 well
- 3 measuring points for groundwater level

Learning objectives
<ul style="list-style-type: none"> <li>■ determining the groundwater level</li> <li>■ lowering of groundwater level via two wells</li> <li>■ groundwater flow on excavation pits</li> <li>■ groundwater studies under concentric load on the substrate</li> </ul>

The experiment tank is fitted with an inlet at both ends. The study of various drainage processes is made possible by two wells. You can activate the inlets and wells independently of each other. This results in many experimental possibilities.

In order to determine the groundwater levels, the experiment tank is equipped with a total of 19 measurement points. The groundwater levels are clearly displayed on tube manometers. In addition to the tube manometers, scales on the side allow for easy and accurate reading of groundwater levels.



Product No.  
070.16700  
More details and technical data:  
[gunt.de/static/s3195\\_1.php](http://gunt.de/static/s3195_1.php)



# HM 169

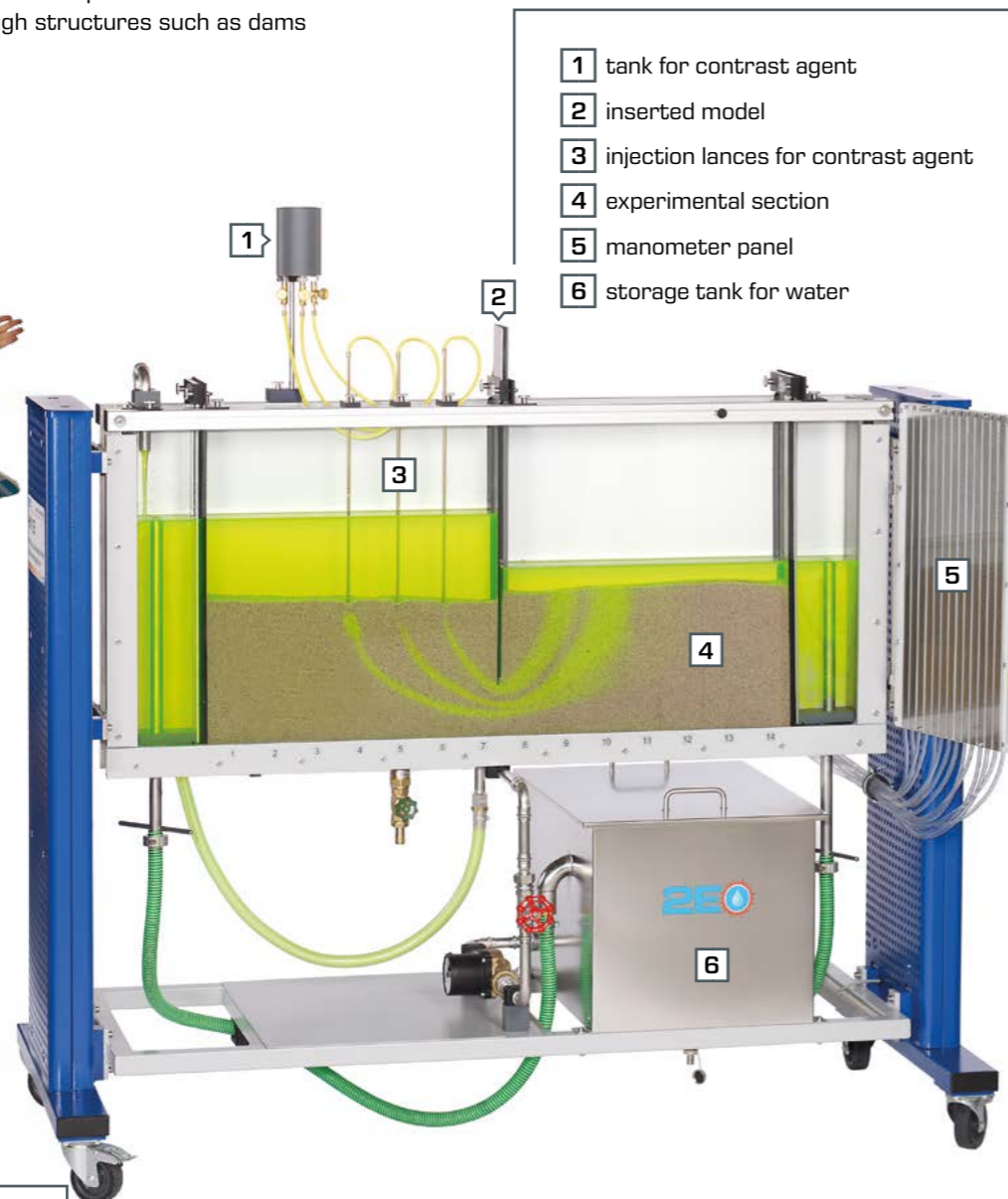
## Visualisation of Seepage Flows

### Seepage flows – protection of groundwater and structures

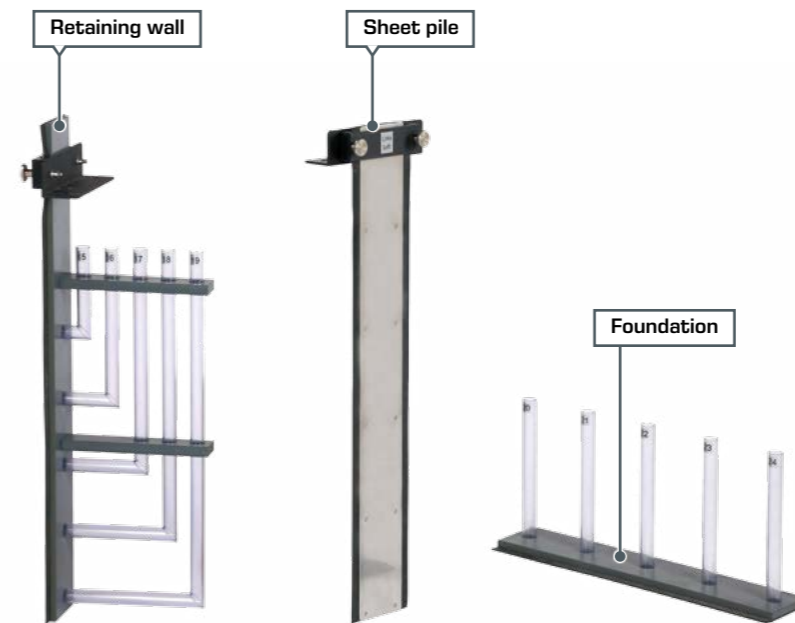
Seepage flows play a crucial role during construction in water-bearing layers. On the one hand, the flow through and flow around structures is relevant. On the other hand, the hydrostatic pressure acting on the structures is also of interest.

A descriptive method in the study of seepage and groundwater flow is the visualisation of the streamlines and their graphical representation as a flow net. The flow net provides information about the seepage of water through structures such as dams and sheet piles.

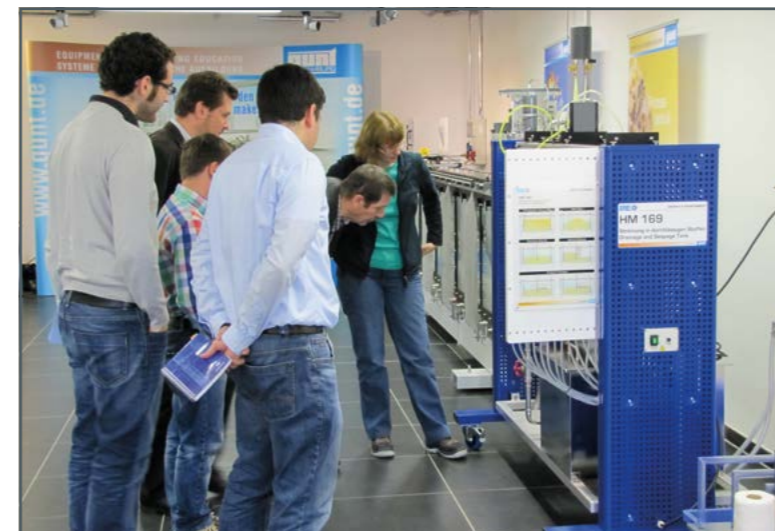
Our HM 169 device allows you to clearly visualise and investigate streamlines around structures. To do this, various models of typical structures which you can easily insert into the experimental section are available.



Product No.  
070.16900  
More details and technical data:  
[gunt.de/static/s3197\\_1.php](http://gunt.de/static/s3197_1.php)



By injecting a contrast agent, such as fluoresceine or ink, the streamlines can be made very clearly visible. The pressure curves of these structures are also displayed in both the "retaining wall" and "foundation" models. The groundwater levels in the experimental section can be measured easily and with great accuracy by using tube manometers.



The possibilities of HM 169 are demonstrated to interested members of staff at Regensburg University of Applied Sciences (Germany).

Learning objectives	
■	determining flow nets in permeable media graphically <ul style="list-style-type: none"> <li>▶ streamlines under a sheet pile</li> <li>▶ streamlines through an dam</li> <li>▶ drainage at an open ditch</li> </ul>
■	determining the pressure curve at a foundation
■	determining the pressure curve at a retaining wall
■	groundwater levels over time in various models

# Basic Knowledge Soil Treatment



## Contaminants in the soil – a threat to the environment

In the past, the use of environmentally hazardous substances was often not given the necessary attention. This allowed toxic substances, such as chlorinated hydrocarbons, to enter the ground in many places. Much of this contamination comes from landfills and former industrial sites and poses a threat to the environment, and to groundwater

in particular. Remediation of the contaminated soil must be undertaken in such cases. A number of different methods are available depending on the type of soil and type of contamination.

## Soil: a multi-phase mixture

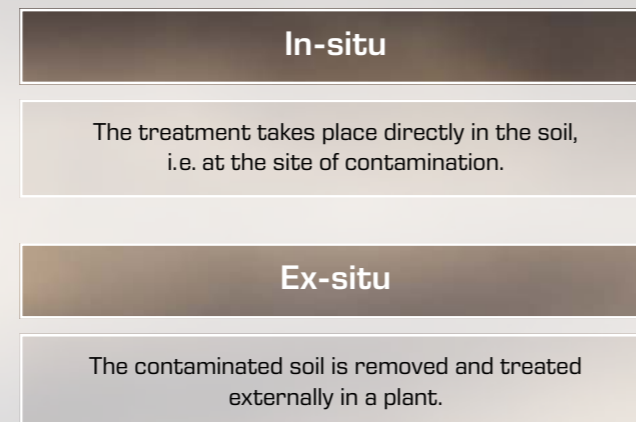
Usually all three phases (solid, liquid and gaseous) are encountered in the soil. Similarly, all three phases can be affected by contamination. Soil treatment requires a holistic approach which takes all three phases in the soil and their complex interactions into account.



## Treatment of contaminated soils: a complex task

The main objective of soil treatment is to protect the groundwater and – as far as possible – to restore the original function of the contaminated soil. Due to the fact that all three phases can be affected by the contamination, soil treatment is a very complex task.

In addition to the contaminated soil, loaded contaminated water and exhaust air also usually occur during treatment. These also require treatment, for which, in turn, current processes of water treatment and air pollution control are used. Fundamentally, two different approaches can be distinguished in soil treatment:



## In-situ soil treatment

In-situ treatment of soils is particularly suitable for the liquid and gaseous phase:

- **liquid phase:** pump and treat
- **gaseous phase:** soil vapour extraction

In both methods, the fluid is pumped out of the ground, the contaminants separated from the fluid and the cleaned fluid then passed back into the soil. The separation of contaminant and fluid is performed either with conventional methods for water treatment (pump and treat) or with the processes of air pollution control (soil vapour extraction).

## Ex-situ soil treatment

In the ex-situ treatment of soils the contaminated soil is firstly removed. Then the soil is treated in special plants. Most methods used here have their origins in the field of mechanical or thermal process engineering. Typical processes used for soil treatment include:

- comminution
- screening
- solid-liquid separation
- separation of small particles (e.g. with hydrocyclone)
- solid-liquid extraction

# CE 225 Hydrocyclone

## Hydrocyclones in soil treatment

Experience has shown that contaminants in contaminated soils are mainly bound to finer particles and organic components. Hydrocyclones can be used to separate these fine particles in order to subsequently treat them with other processes, such as solid-liquid extraction.

With our CE 225 trainer, you can clearly demonstrate and investigate how a hydrocyclone works in a practical manner. You are assisted in this task by the comprehensive instructional material, which also gives suggestions on conducting experiments.



Product No.  
083.22500  
More details and technical data:  
[gunt.de/static/s4835\\_1.php](http://gunt.de/static/s4835_1.php)



The core element of CE 225 is the transparent hydrocyclone for optimal observation of the separation process

The device features a large storage tank, in which the suspension to be separated is positioned. The cyclone is made of transparent material to make the separation process optically visible. The flow rate in the inlet of the cyclone can be adjusted individually and is measured by an electromagnetic flow meter.

You can take samples from all relevant points of the device in order to assess the experiments quantitatively.

Learning objectives
<ul style="list-style-type: none"> <li>fundamental principle and the method of operation of a hydrocyclone</li> <li>solid mass flow rate in feed, top and bottom flow</li> <li>liquid mass flow rate in feed, top and bottom flow</li> <li>characteristic values for sharpness of separation</li> <li>pressure loss at the cyclone dependent on the feed flow rate</li> <li>influence of solids density on characteristic values and pressure loss</li> </ul>

This device has been developed by our experienced engineers in collaboration with the Institute of Mechanical Process Engineering at the Anhalt University of Applied Sciences (Germany).

**Hochschule Anhalt**  
Anhalt University of Applied Sciences

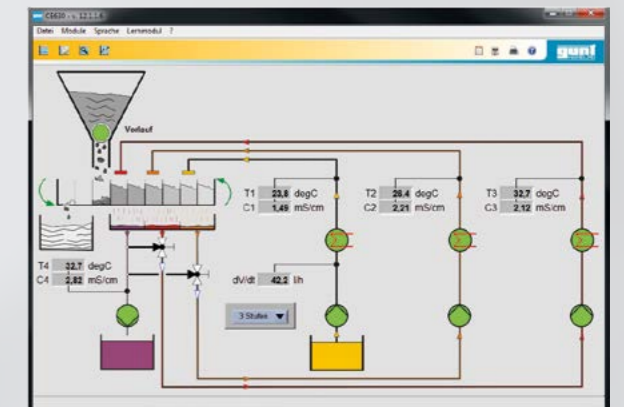
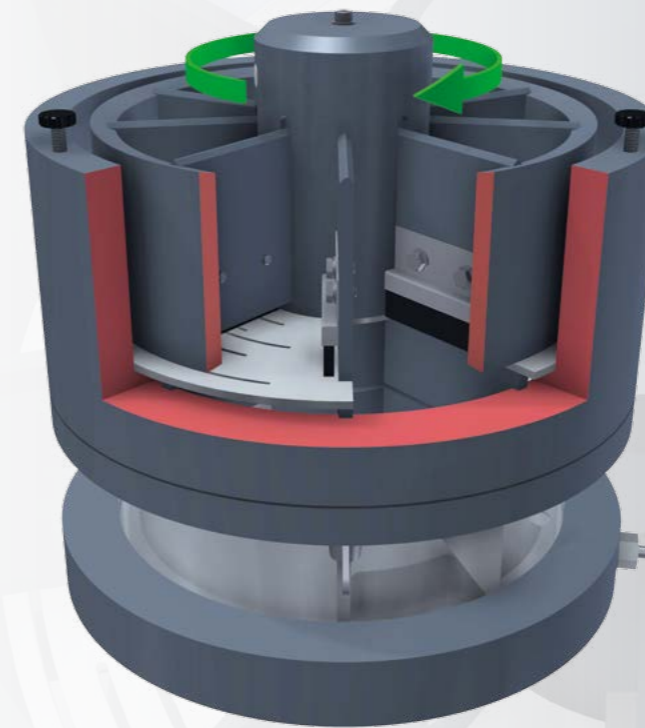
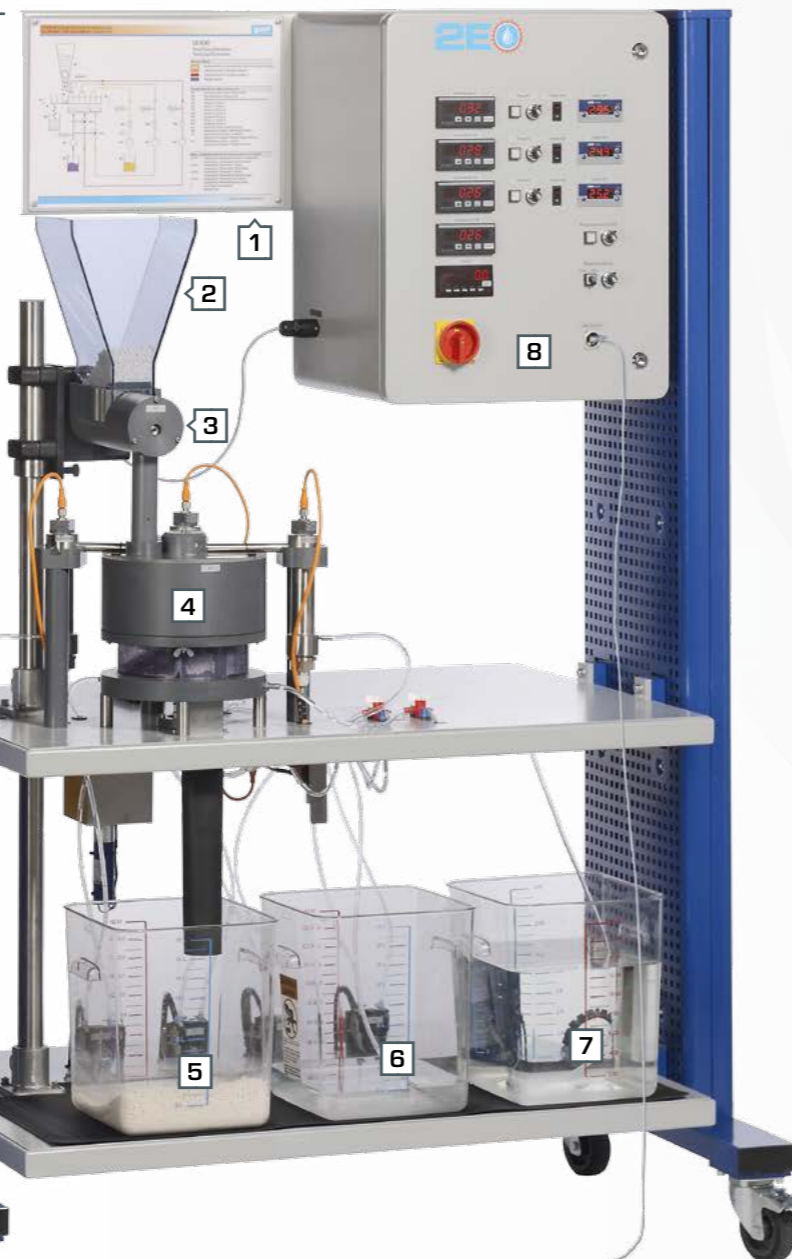
# CE 630 Solid-Liquid Extraction

## Application of a thermal separation process in soil treatment

Contaminants may be present on the solid particles of the soil in a sorbed state. Solid-liquid extraction enables the separation of these contaminants from the soil particles. A suitable solvent needs to be selected for this process depending on the contaminant and the type of soil.

Our CE 630 teaching device is particularly suited to demonstrating the basic principle of this process practically and clearly. You can use the device either in continuous or discontinuous mode. In addition, you can adjust the temperature of the solvent.

- 1 process schematic
- 2 container for extraction material (solid)
- 3 solids dispenser
- 4 extractor
- 5 collection tank for extraction residue
- 6 collection tank for extract
- 7 storage tank for solvent
- 8 switch cabinet with control elements and digital displays



### Software

The device is equipped with software which displays all key process variables continuously. You can save the recorded measured values to analyse the experiments.

## Rotating extractor

The main component of CE 630 is a rotating extractor, which is divided into several chambers. The extraction material, i.e. the solid with the substance to be eliminated, enters these chambers. The solvent enters the chambers from above via three sprinklers and absorbs the material to be extracted. A 3-stage process control is possible due to the rotation of the extractor. You can adjust the speed of the extractor.

### Learning objectives

- basic principle of solid-liquid extraction
- influence of operation mode (continuous/discontinuous)
- investigation of the 1-stage, 2- stage and 3-stage process
- typical parameters influencing the process:
  - ▶ solvent flow rate
  - ▶ solvent temperature
  - ▶ extraction material flow rate
  - ▶ extractor speed



A satisfied lecturer at the Industrial College in Yanbu (Saudi Arabia) after successful commissioning of CE 630



Product No.  
083.63000  
More details and technical data:  
[gunt.de/static/s3578\\_1.php](http://gunt.de/static/s3578_1.php)



## Environment

**Soil:**  
hydrogeology

**HM 165**  
Studies in hydrology

Investigation of precipitation-discharge relationships, storage capacity of soils, seepage flows and ground-water flows


 Order No.:  
070.16500

**HM 141**  
Hydrographs after precipitation

Correlations between precipitation and percolation; storage capacity and drainage methods


 Order No.:  
070.14100

**HM 167**  
Groundwater flow

Three-dimensional investigations and demonstration of flood and drainage


 Order No.:  
070.16700

**HM 169**  
Visualisation of seepage flows

Graphical determination of flow fields and investigation of water pressure on structures


 Order No.:  
070.16900

## Environment

**Soil:**  
soil treatment

**CE 225**  
Hydrocyclone

Separation of solids from liquids by using a centrifugal force


 Order No.:  
083.22500

**CE 630**  
Solid-liquid extraction

Continuous or discontinuous extraction of the soluble components of a solid mixture using a revolving extractor


 Order No.:  
083.62000


## Environment

**Waste:**  
comminution

**CE 245**  
Ball mill

Observation of the grinding process with regards to the comminution of solids

 Order No.:  
083.24500


## Environment

**Waste:**  
separation processes

**CE 275**  
Gas flow classification

Zigzag sifter to separate solid compounds

 Order No.:  
083.27500

**CE 280**  
Magnetic separation

Sorting with a drum-type magnetic separator

 Order No.:  
083.28000
