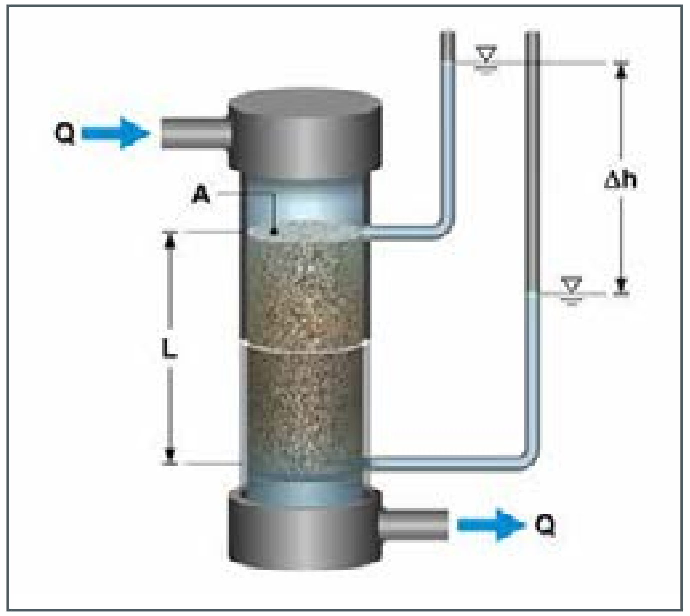
CE 117
Flow through particle layers

Seepage flow

In hydrology, seepage flow refers to the flow of a fluid (water) in permeable soil layers such as sand. The fluid fills the pores in the unsaturated bottom layer and moves into the deeper layers as a result of the effect of gravity. The soil has to be permeable so that the seepage water is not stored.

In less permeable soils the seepage water can be stored temporarily. If the seepage water encounters an impermeable soil layer or impermeable rock, seepage will no longer take place and the seepage water accumulates permanently. Such underground water accumulations are known as groundwater. In hydraulic terms, seepage flow corresponds to the flow through a particle layer.



Flow through a particle layer

Darcy's law

Exploration of the fundamental relationships in flow through particle layers goes back to **Henry Darcy** (1803-1858).

As flow passes through a particle layer, the particle layer resists the flow, which leads to a pressure loss. **Darcy** found that with laminar flow there is a linear relationship between the flow rate **Q** and the pressure loss (differential pressure head **Δh**).

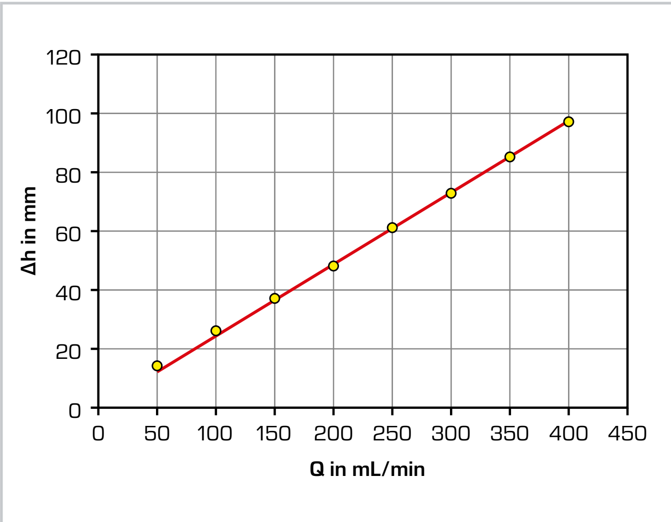
$$Q = k_f \cdot A \cdot \frac{\Delta h}{L}$$

The dimensionless variable **Δh/L** is denoted as the hydraulic gradient. The permeability is described by the coefficient of permeability $\mathbf{k_f}$ in the unit m/s and is dependent on the grain size and the useful pore space.

Experimental unit CE 117

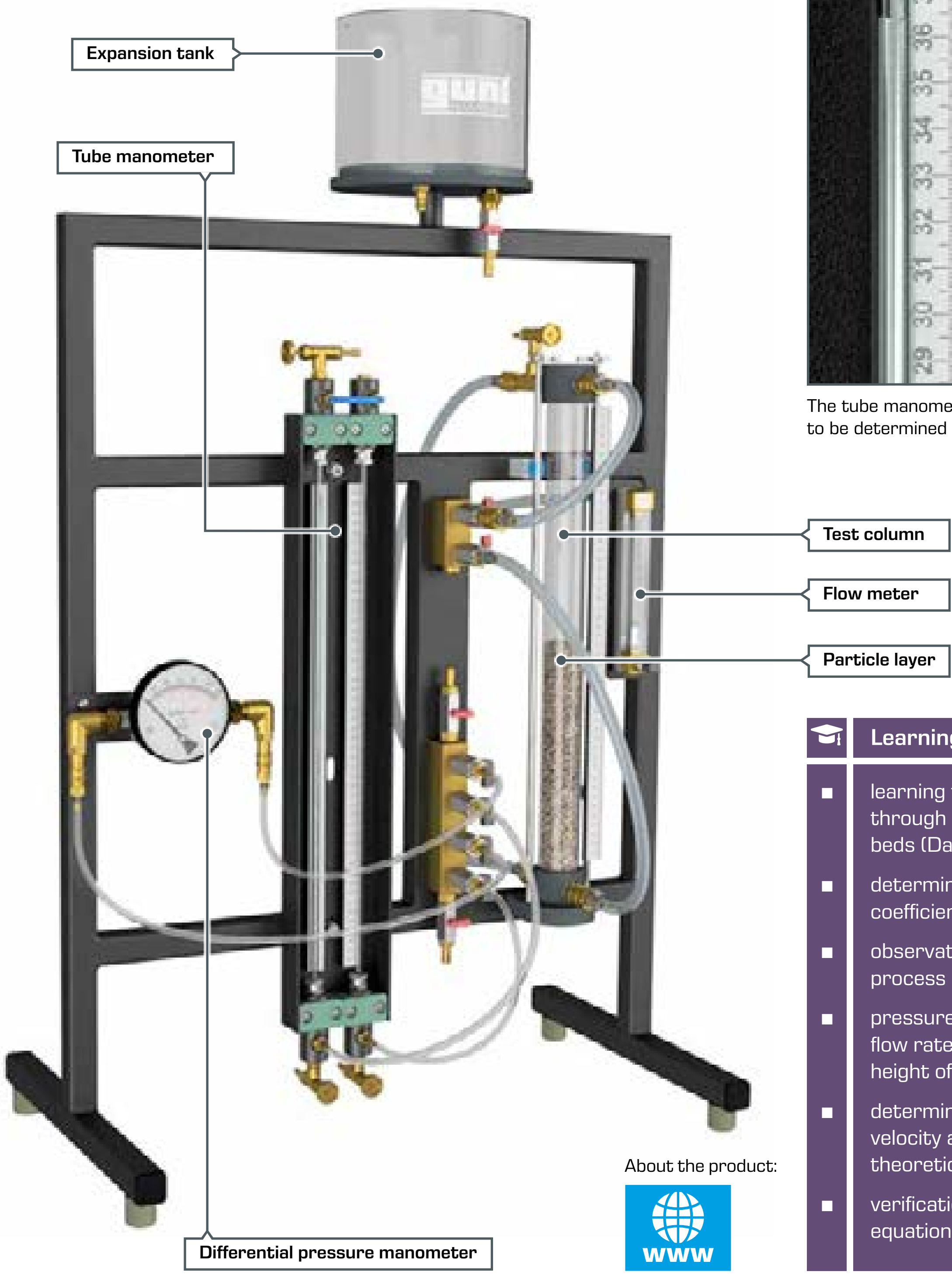
The experimental unit CE 117 can be used to investigate the fundamental fluid mechanics of flow through packed beds. The experimental unit has a transparent test tank which allows optimal observation of the processes. To determine the pressure loss, two manometers with differing measuring ranges are provided.

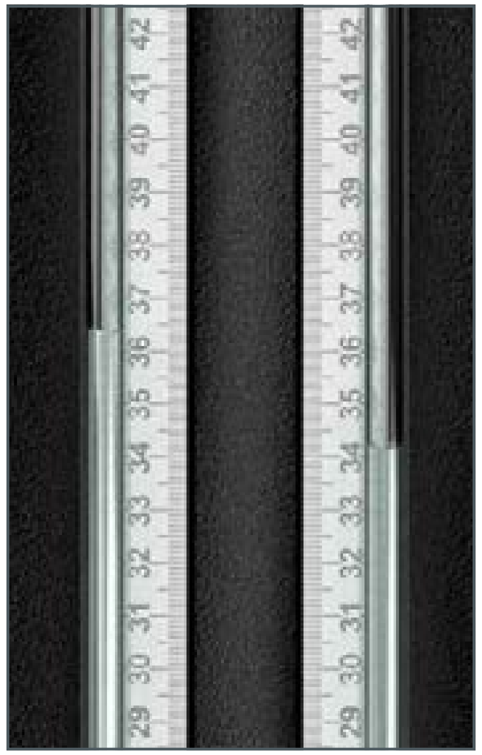
The experimental setup can be modified by means of quick-release couplings. This also enables the flow through the test tank to be reversed and fluidised beds to be investigated. The flow rate is adjusted by a valve and indicated by a flow meter.



Measured differential pressure head **Δh** as a function of the flow rate **Q** (sand: d = 1...2 mm, L = 60 mm)

- experiments in the fundamentals of fluid mechanics on particle layers
- flow through fixed beds
- flow through fluidised beds
- pressure loss in fixed beds and fluidised beds





The tube manometer enables low pressure losses to be determined with a high degree of accuracy.

About the product:

www

Learning objectives

- learning the fundamentals of flow through fixed beds and fluidised beds (Darcy)
- determination of the permeability coefficient
- observation of the fluidisation process
- pressure loss dependent on the flow rate, type, particle size and height of the bulk solid
- determination of the fluidisation velocity and comparison with theoretically calculated values
- verification of Carman-Kozeny equation