

Hydraulic borehole testing

Solexperts offers high quality equipment and methods for in situ hydrogeological exploration. For the three-dimensional hydraulic characterization of investigation sites, Solexperts AG has developed a double packer system that is characterized by its modular design and high reliability. The mobile measuring equipment has been further developed for 30 years and has proven itself in numerous hydrogeological investigations in the engineering and environmental fields.

Areas of application:

- Contaminated sites
- Potential landfill sites
- Sealing barriers
- Tunnel projects
- Underflow and dam bypass
- Drinking water aquifer
- Geothermal projects
- Detection of casing leaks
- Depth-specific groundwater sampling

with double packer system



Fig. 1

Hydraulic borehole testing with the double packer system

Hydraulic borehole tests using the double packer system (Fig. 1) are carried out layer-specific to determine the hydrogeological parameters.

- Transmissivity (T),
- Permeability coefficient (K) and
- Piezometric pressure head (h)

The use of packers makes it possible to hydraulically isolate freely selectable rock sections and to investigate them separately from the rest of the borehole. After a test, the packers can be released and moved to another depth position. The aim is to show the variation of the properties of water-bearing and/or retaining layers in the depth profile (Fig. 2).

On the basis of packer test measurement profiles from several boreholes, a 3D image of the permeability and hydraulic potential conditions of the subsurface can be created. If required, the data can be transformed into a flow or transport model.

Solexperts double packer systems allows for layer-specific groundwater sampling. If flow directions or flow porosity in rock strata need to be clarified, packer tests can be combined with tracer tests.

The equipment

The downhole instrumentation includes packer, installation rods, probe and shut in valve), the control unit for flow and pressure, and the data acquisition.

In the borehole:

The packer system is installed in the borehole with rods (test pipe).

The double packer consists of two

expandable packers which are controlled by separate pressure lines (Fig. 2). When the packers are expanded (pneumatically or hydraulically) a borehole section is isolated. The length of the test interval can be varied.

The pipe connection between the packers contains a perforated intermediate piece that provides the hydraulic connection between the test zone and the test pipe. The 3-fold pressure probe directly above the packer system continuously measures the pressure in the test interval (P2) as well as below (P1) and above (P2) the double packer. With this arrangement, any bypass flow of the packers

can be detected. Another sensor measures the temperature in the flow channel of the probe. The valve above the probe (borehole or shut-in valve) can be used to shut in the test interval or to open a connection from the interval to the test tubing. The shut-in valve allows to run modern hydraulic test procedures such as slug/pulse tests as well as other "shut-in" tests. (Fig. 3)

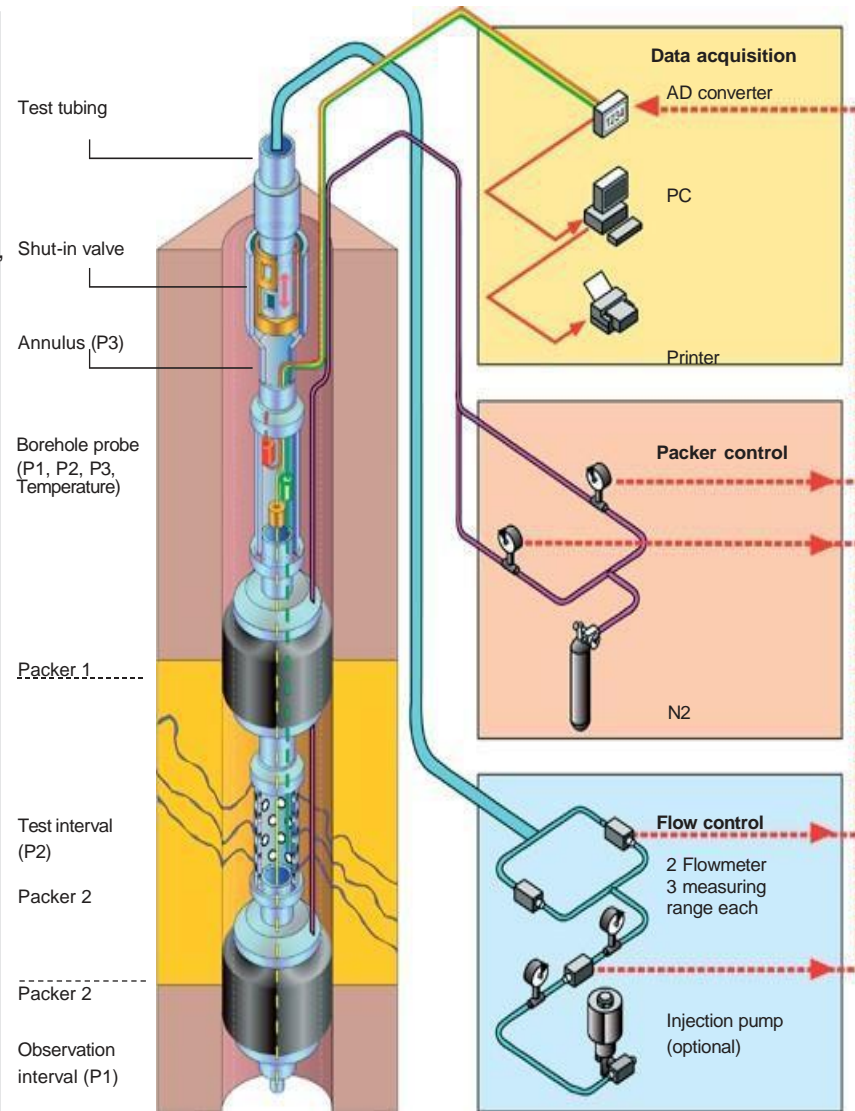


Fig. 2: Schematic representation of the double packer system

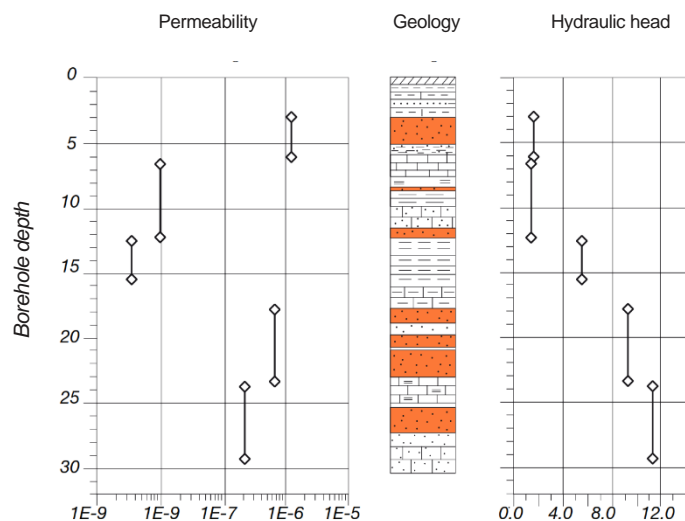


Fig. 3: Representation of double packer test results in a vertical profile.

Flow/Pressure Control Unit and Accessories

The hydraulic test procedures require precise control of the injected or pumped water volumes as well as the injection pressures. The flow/pressure control unit contains control valves and flow meters for different measuring ranges.

The control unit can be supplemented with additional modules according to the current test requirements, such as:

- Special valves for constant flow or pressure
- Flow through unit for recording chemo-physical parameters
- Tracer tank (for tracer tests)

Data acquisition

The measurement parameters pressure, flow and temperature are continuously recorded via a PC-controlled data logger and displayed online on the screen. Additional, easily configurable measuring channels are available, for example, for pressure measurement in secondary wells, for recording water quality, etc. The on-line analysis of the test data on site is supported by the HUGO software. This allows the test sequence to be continuously checked and the test times to be optimized. Graphical representations, test results, logbook and raw data are available to the customer on request on the same day. In addition, SAPHIR (oilfield software tool) is available for detailed test analysis (e.g. double porosity, different aquifer and confinement models) (Fig. 5).

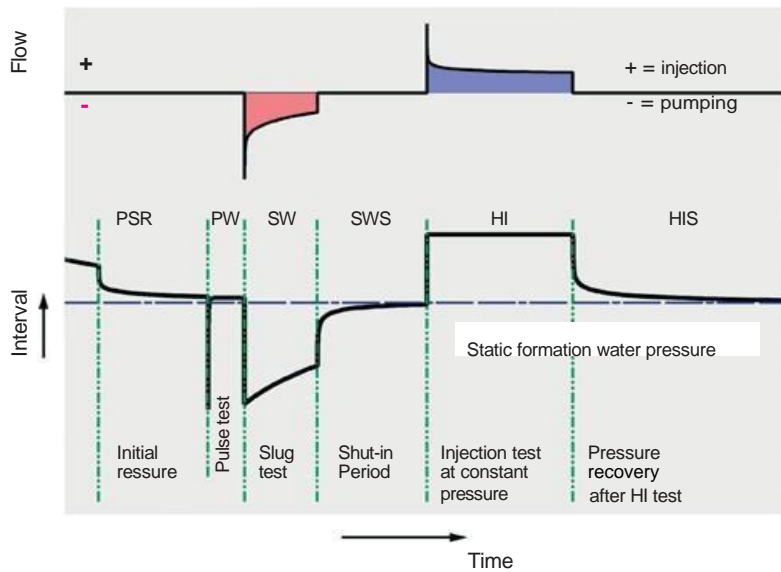


Fig. 4: Typical test sequence for permeable test intervals

For the determination of the hydraulic parameters, the following test procedures can be carried out with the double packer system:

- Injection / pumping test with constant pressure difference ("Constant Head" test)
- Injection / pumping test with constant flow rate ("Constant Rate" test)
- Pressure recovery after Constant Head/ Rate test
- Slug tests
- Positive or negative pulse tests

A typical test sequence is shown in Fig. 4.

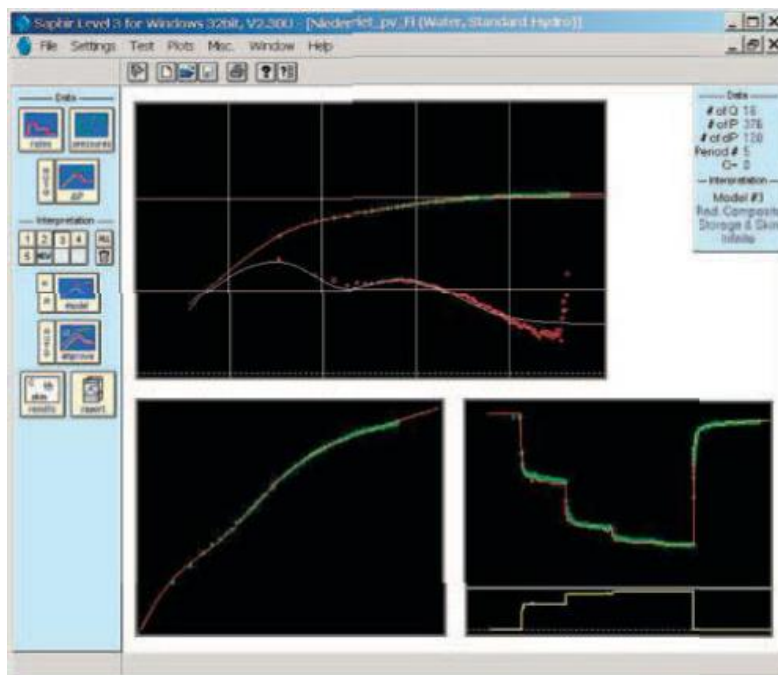


Fig. 5: Detailed test analysis using SAPHIR software

Other products and services of Solexperts- Hydro Group are:

- Well testing in deep wells
- Wire-Line Testing
- Hydrogeological instrumentation
- Conception and realization of hydraulic tests in rock laboratories
Online tracer tests in saturated and unsaturated areas
- Detailed analysis of hydrogeological test data with modern software
- Special products for drinking water well rehabilitation
- Hydraulic packer test systems designed according to customer requirements

Contact us - we will be happy to propose an individual solution for your hydrogeological testing or monitoring project.

Specifications of the Double Packer Standard System (DPSS):

Automatic data acquisition

- Software: Solexperts DQ or GeoMonitor
- A/D converter: 20 channels, resolution 100 μ V, range 0 - 3 Volt

Probes

- Outer diameter: 80 mm
- Measuring ranges (depending on probe type): P: 0 - 50 bar, T: -40°- 80°C

Test rod (with O-ring seal)

- 2-inch stainless steel: ID = 52 mm, OD = 60 mm, socket OD = 80 mm
- 1-inch steel: ID = 25 mm, OD = 35 mm, socket OD = 46 mm

Packer

- Length: 1.0 m
- Diameter: variable, see table
- Packer inflation medium: water or N2 gas
- Minimum interval length: 1.3 m

Maximum DPSS working pressures (bar):

• Drill hole \varnothing (mm)	100	110	125	130	145	180	190	200	270
• Packer- \varnothing -85 mm	55	40	30	25	20	10	-	-	-
• Packer \varnothing 100 mm	-	75	65	65	50	35	30	-	-
• Packer \varnothing 130 mm	-	-	-	70	45	40	35	15	-
• Packer \varnothing 170 mm	-	-	-	-	-	80	70	60	30

Ideal DPSS application areas:

- Packer- \varnothing - 85 mm Drill hole diameter 100 - 150 mm
 - Packer- \varnothing - 100 mm Drill hole diameter 130 - 180 mm
 - Packer- \varnothing - 130 mm Drill hole diameter 160 - 240 mm
 - Packer- \varnothing - 170 mm Drill hole diameter 180 - 270 mm
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Maximum installation depth: 300 m

- For applications in larger borehole depths please ask for the brochure HDDP- Heavy-Duty Double Packer System

Subject to technical changes

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