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Tiny diameter downhole pressure monitoring

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Cheap and efficient groundwater pressure monitoring is a standard task in subsurface hydrology. We present application experience from a tube based pressure monitoring system that is applied to the Svelvik field laboratory for CO_2 storage, Norway. In total 13 monitoring points were installed in depths between 51 and 89 m below ground level.

The pressure sensor is located above ground. It is temperature compensated to reduce measurement errors due to temperature variations. The pressure sensor is connected to a downhole low diameter tube that has a perforation in the respective measurement depth. The tubes are installed as smart casing installations, i.e. in the borehole annulus. This allows to keep the borehole open during installation of other monitoring devices.

Clean pumping of the well was not possible. Some filters were protected with fleece, while others were just perforated tubes. During installation, all tubes had hydraulic contact to the groundwater. After settling of the mud 3 of 4 fleece protected filters show sufficient communication, while all 9 filters that were just perforated were clogged and not usable for pressure monitoring.

The system has following advantages: (i) the downhole material is robust and cheap, allowing for multiple measurement points; (ii) has a small diameter (6 mm in the present case); (iii) since the static pressure is removed, a smaller sensor range is required; (iv) the sensors are located at the top of the borehole and can be retrieved after the campaign. Further, it can be installed without downhole metal parts.

The system has two disadvantages by design compared to submerged pressure sensors. (i) The absolute pressure can only be approximately determined, limited by the accuracy of the fluid density inside the tube. (ii) Pressure decreases can only be measured up to about 1 bar below piezometric head when the tube is filled with water.

The upper metres, that may be exposed to temperatures below 0 °C are filled with antifreeze. The choice of antifreeze allows for a certain static pressure correction. Minimum weight liquid is pure ethanol with a density of about 0.8 kg, allowing to measure pressure up to 2.8 bars below piezometric head for e.g. the 89 m deep measurement.

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