Sinusoidal Slug Testing

Underground water supplies are being detrimentally affected by contamination and overuse. Aquifers are being affected by domestic, industrial and agricultural contaminates, such as PFAS and micro plastics finding their way onto the underground water systems. The need to study how these plumes travel through aquifers if of the utmost importance. Overuse of underground water supplies leads to a lowering of the water table and eventual depletion of the resource. Monitoring just these two issues is becoming more and more urgent.

Groundwater accounts for over 30% of Australia's total water consumption, highlighting its importance as a vital resource. However, to date no standard, reliable method has been developed to measure the health of these aquifers.

Ascertaining the characterises of aquifers with any degree of accuracy has been a problem for hydrologists because the aquifers are hidden below ground and difficult to access. While sinusoidal technology is not new (it is used in devices from MRIs to household scales), its use in analysing groundwater transport is. CSIRO and Flinders University approached Kremford Pty Ltd to develop the scientific advances they had been making with sinusoidal wave testing equipment. Together this group cooperatively developed field equipment to measure and display the Transmissivity, Hydraulic Conductivity and Storage coefficient of aquifers using sinusoidal technology.

The field equipment was appropriately called Limax and consists of a tripod through which a 6-meter solid rod or 'slug' is lowered down a borewell in a controlled manner by a computer-controlled winch. As the slug displaces the water, it creates a sinusoidal wave that is monitored in both this well and one or two nearby observation wells.

Periodic oscillations of a solid cylindrical slug in a production well create water level fluctuations as a series of sinusoidal waves that propagate to nearby observation wells. Pressure sensors in all wells during testing provide time-based measurements over a wireless network at user-specified sample intervals and are automatically recorded by the field equipment. Calibrated and auto-scaled graphics update at every sample to display the sensor readings along with the current slug position in a visual indication of how the test is proceeding. The recorded pressure head fluctuations from all wells serve as inputs to aquifer test analysis software. Because the results to date can be copied to the user's computer at any time, an analysis can present results in near real-time. Typical results include estimates of aquifer transmissivity, storativity, and other important hydraulic properties. Together these provide an accurate and current picture of the aquifer's hydraulic characteristics.

All parameters that specify the slug travel, its sinusoidal period and test length are all easily setup via remote control. A variety of excitation sequences are available including single frequency, multiple frequency, and swept frequency, each easily setup and verified. The operator has instant visual access to both the current slug position in the well and the outputs from all sensors. The test so far can be downloaded to the laptop as data for on-the-spot analysis by the user's own proprietary software.

This new technology has applications in industry, mining, agriculture and is a useful tool for government to monitor the health of our groundwater resources.

Please see www.kremford.com.au for further information.