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ULTRASONIC Ultrasonic test in geothermal heat exchangers (bhe) to monitor grout integrity against migration of contaminants into ground water system.TEST IN GEOTHERMAL HEAT EXCHANGERS (BHE) TO MONITOR GROUT INTEGRITY AGAINST MIGRATION OF CONTAMINANTS INTO GROUND WATER SYSTEM.

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Geothermal heat pumps uses are not common in Italy, contrary to Central and Northern Europe examples. As for all relatively new techniques, there is a general apprehension mainly due to two questions: 1) Is it working? 2) Is it a possible source of pollution for water tables? Thermal response tests can answer question n.1. They can integrate the underground thermal properties along the entire length of a BHE, including groundwater and backfilling material, providing a so-called “effective” thermal conductivity as defined under strict heat conduction assumptions. Laboratory measurements alone may lead to different values since they cannot correctly account for groundwater flow and water-filled cracks and pores. Question n. 2 is still a problem. Actually, the only assurance that the PVC pipes are completely insulated from the ground (and from the aquifers) is given by the blowing up of the backfilling material, pumped up from the bottom of the drilling.
Vertical ground loop heat exchangers typically consist of high-density-polyethylene (HDPE) pipe U-tubes inserted in deep boreholes. A grout mixture is typically pumped into the borehole to fill the gap between the U-tube and the borehole walls. The purpose of the grout is to improve the heat transfer between the soil and plastic pipes by providing a better contact surface between them, and also to provide a seal around the U-tube to guard against migration of contaminants into the ground water system.
The purpose of these experiments is to assess the homogeneity and integrity of concrete between one or more access tubes. Test equipment includes an ultrasonic transmitter, a matched receiver and a data acquisition system. Testing is done by lowering the transmitter and receiver on top of each other and then scanning the pile as the two are retrieved. The records of signal travel time (and relative strength) yield an assessment of the concrete quality and continuity. Several problems must be however taken into consideration. First usually small diameter tubes are used so that the insertion of the ultrasonic sonde is not possible. Secondly the tubes are not perfectly vertical one to each other and can be quite tortuous so that a good calibration of data is not always possible.
An experimental pile about 4 m high and constituted by a 1:1 mix of concrete and bentonite was built. Some defects, layers of coarse sand mixed with expanded clay, have been moreover placed in the pile at different heights. Two access tubes have been inserted in the pile and have been filled with water. After the execution of the tests, a window was opened in the pile in order to verify experimental data.
Preliminary test presented underline the potentiality of the ultrasonic tests in cementation defect identification for BHE monitoring. Technical problems (mainly tube diameter and signal coupling in single hole tests) have however to be solved for an application of the technique to real case histories. At the same time more sophisticated signal interpretation techniques could lead to a clearer identification of defects. Anyway, this technique open a new vision on the field of environmental certification, permitting to highlight situation in which borehole heat exchangers can be a possible source of pollution or, simply, can put in connection different aquifers due to lack or poor cementation of the space between pipes and ground.