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PENETRATION BEHAVIOR OF A FRESH WATER STREAM INJECTED INTO BRINE AND THE INFLUENCE ON CONCENTRATION DISTRIBUTION DURING CAVERN LEACHING PROCESS

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Abstract

Experiments were conducted to evaluate the vertical penetration of an injected fresh water stream into brine during cavern leaching process. The purpose of these tests was to additionally determine the shape and size of the water jet when discharging the pipe as well as its influence on the vertical salinity gradient in the cavern.

A test set-up consisting of a brine filled glass tank equipped with an adapted and downscaled leaching completion was used to investigate the above mentioned flow patterns. Various injection velocities and brine concentrations were applied to obtain data of the maximum penetration depth of injected water into brine. The development of the barrier layer in the maximum penetration depth of the fresh water jet was examined by applying schlieren flow visualization and by colorization of the brine.

This paper describes an empirical calculation method derived from experimental data to determine the vertical penetration depth and the radial spread of the fresh water jet into the brine. The penetration depth of the fresh water jet was formulated as a function of fresh water flow rates, local density differences between brine and fresh water and the diameters of the leaching pipes. The observed influences of the fresh water stream on the concentration distribution enabled the detection of a barrier layer, which separates the gravity stratification zone and the turbulent mixing zone. The results were compared with density measurements from sonar surveys conducted in existing caverns to detect the barrier layer. The actual results of the sonar surveys confirmed the calculated values.

This paper also describes the effect of turbulent mixing at high flow velocities due to the entrainment of brine into the stream of fresh water. This may be a reason for the homogeneous concentration distribution in the zone above the water injection point. As an outcome of the experimental studies a minimum vertical distance between the outer- and the inner leaching string depending on the maximum flow rate can be estimated to avoid production of the injected fresh water.

Key words: cavern leaching, concentration distribution, submerged turbulent jet

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