Pilot scale tracer study to investigate the efficiency of a drip irrigation and tile drainage system for salt remediation

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Abstract

Within any industry come the risks associated with producing, refining and selling a product. The oil and gas industry is no exception to this and faces the risk of accidents during all stages of production. Spilling hydrocarbons, produced water and other hazardous materials are situations that occur and must be dealt with accordingly. One such scenario that proves challenging is the remediation of produced water. Saline water spilt over an area of land used for agriculture will make it difficult to grow crops and could possibly render the land unfit for agricultural use. One basic method of saline soil remediation is the installation of a tile drain system accompanied by irrigation of the affected land to leach the salts from the soil. Many site specific factors can influence how well this method works including soil hydraulic characteristics, macroporosity, precipitation and tile drain spacing.

In our investigation, a field scale tracer experiment was conducted to test the effectiveness of using a tile drain system for a salt remediation project in west central Alberta. The experiment was designed to investigate and characterize the flow occurring at the site and determine how macroporosity affects the groundwater flow regime. The site can be characterized as glacial lacustrine silty-fine sand underlain by a relatively impermeable till layer approx 2 m below ground surface. Tensiometers and monitoring wells were installed in and around the plot to monitor soil water changes and a monitoring system has been installed on the two tile drains beneath the plot to characterize flow volumes and water chemistry. The tracer used in this experiment was 2,6-difluorobenzoic acid [2.6-DFBA] which in previous studies has been found to act as a conservative compound. The total mass of tracer applied to the 400m^2 study plot was 4.5kg mixed in with 5200L of water. The tracer was applied using drip line irrigation for 85 minutes. Irrigation of the study plot continued after the application of the tracer on a schedule that averaged roughly 5000L/day, applied 3 days a week. Automated samplers began collecting water samples 45 minutes after the tracer application and continued every 3 hours for the remainder of the experiment. Analysis of the tracer was done using high precision liquid chromatography.

Initial breakthrough of the tracer occurred approximately 1 day after application and was detected in water samples for the remaining 52 days of the water sampling program. Analysis of water samples collected from monitoring wells within the study plot showed preferential flow was occurring within certain locations of the study area as well high EC measurements indicated salt has been flushed from the soil. The amount of tracer recovered by the tile drain

represented only a fraction of what was initially applied. As well, soil cores of varying depths have been taken from the study plot and are currently in the process of being analyzed for the tracer. The results of the experiment are being used to help delineate flow paths and the roles of matrix and macropore flow. Preliminary results indicate that macropore flow is occurring, but does not appear to be significantly affecting the flushing of salts.

Summary

Remediation of salt affected soils can be a difficult task because of the many site specific conditions unique to each site. Buried tile drains can collect salt-affected infiltration water and help remove salt from the subsurface. This poster focuses on a tracer experiment conducted at salt remediation site located SW of Devon, Alberta. 4.5kg of 2,6-difluorobenzoic acid was applied to a 400m^2 study plot in hopes to determine whether any preferential flow was occurring, along with mapping the flow patterns of the irrigated water. Along with water samples from the tile drains, water samples from monitoring wells located in and around the study plot and soil samples located within the plot were used to help delineate flow paths and the roles of matrix and macropore flow.

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