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HISTORY OF TWO-WELL INDUSTRIAL WASTE-DISPOSAL SYSTEM

A 6-year study of a 2-well underground injection system (from 1964 to 1970) was conducted by Bureau of Mines engineers. Observations made from this survey include (1) selection of underground injection as the best solution to the waste-disposal problem, (2) origin and analyses of two separate waste streams, (3) surface equipment used for preinjection treatment of wastes, (4) well design and completion, (5) local and regional geology, (6) preinjections tests of the wells and laboratory tests of the disposal formation, and (7) the operating history of the 2 wells.

Major constituents of the wastes are propionic acid, phenol, butanol-1, butyraldehyde, and n-hexylamine. The adsorption characteristics of these compounds were determined in an autoclave under simulated reservoir conditions. The equilibrium amounts adsorbed and the effect of pH were determined as functions of concentration. The advance of the waste constituents is retarded by adsorption; thus, a zone develops at the advancing front which is completely depleted of waste constituents. This zone is shown to increase in depth as more of the formation is contacted by the injected fluid. These data are used to calculate the radius of migration of the waste constituents from the wellbore with respect to the total volume of waste injected, for planning waste-injection systems.

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ARTIFICIAL RECHARGE OF TREATED WASTE WATERS AND RAINFALL RUNOFF INTO DEEP SALINE AQUIFERS OF PENINSULA OF FLORIDA

Fast-growing population centers of the state of Florida, mainly in coastal beaches, have imposed large demands on the sources of fresh water. They also threaten to deteriorate the esthetic and recreational value of the area with their waste waters.

The largest of these population centers is on the southeastern end of the peninsula of Florida, commonly referred to as the Miami area. The second largest is on the central west coast of the peninsula in the Tampa-St. Petersburg area.

The Florida peninsula is underlain by several thousand feet of carbonate rock, with only minor amounts of clastic sediments. Cavernous limestone and dolomite aquifers at relatively shallow depths constitute the principal source of fresh water in the area. Deeper cavernous zones, separated from the freshwater zones by practically impermeable limestone and dolomite, are uniquely suited to receiving injected fluids.

Deep-well disposal of waste waters into deep saline aquifers, after secondary biologic treatment and disinfection, is feasible if (1) an aquifer exists that can accept treated waste waters without significant changes in its hydraulic and structural characteristics, and (2) if use of the water in that aquifer, adjacent ones, or from surficial sources is not impaired.

Two large disposal wells have been constructed for a private utility in the Miami area of southeast Florida. They are approximately 3,000 ft in depth and recharge an artesian aquifer having chloride concentrations near that of seawater (19,000 mg/l). The receiving aquifer is overlain by a thick aquiclude, by another aquifer (saline but of lower chloride concentration), and then by a thick, impervious section separating the highly mineralized waters from the shallow and fresh groundwater.

Three concentric steel casings, cemented at the proper depths, permit injection into the deeper aquifer with protection of the upper strata. Monitoring of the upper saline water-bearing stratum, where any possible leak from the deeper aquifer would normally be first detected, is performed through the annulus between the 2 inner well casings. An integrated water-quality aquisition system continuously monitors the injected waste and provides an alarm and pump shut down if established limitations are exceeded.

Operation of the first well for over a year has proved fully reliable, and economically advantageous. Eight similar disposal wells are being considered in the area.

On the basis of this experience, a new research program is being implemented to inject, store, and recover when needed, rainfall runoff into the deep saline aquifers of southern Florida.

A test-prototype well is presently being constructed within the city of St. Petersburg to determine (1) the characteristics of the deep underground formations; (2) the quality of the deep groundwaters; (3) the injection rate capacity and associated increase in pressure; (4) the ratio of the amount of fresh water that could be subsequently recovered to that injected; and (5) the quality of the recovered water.

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MOVEMENT AND ACCUMULATION OF SUSPENDED SEDIMENT DURING BASIN RECHARGE

The movement and accumulation of sediment suspended in water used for recharge were determined by radiotracer techniques and by examining thin sections of recharge basin material with a petrographic microscope. The purpose of the study was to determine suspended sediment accumulation and movement, loci of accumulation, and its effect on the recharge basin life.

The radiotracer study showed that 50% of the sediment suspended in the recharge water moved deeper than 33 cm when naturally occurring large pores were allowed to remain at the basin surface, but only 10% moved deeper than 2.5 cm when these pores were destroyed.

Horizontal and vertical thin sections were made from cores taken from the upper 30 cm of a recharge basin in which the large pores at the surface were destroyed, and that had recharged over 91 m of turbid water in 6 cycles. The nature of the sediment accumulations allowed identification in thin sections of the types, loci, and amounts. Three types of accumulations were observed: (1) flakelike structures on the upper 2.5 cm; (2) two horizontal sheetlike structures, 0.1 mm thick, between the depths of 5 to 8 cm and 8 to 12 cm, respectively; and (3) fillings in voids, mostly between 2.5 and 23 cm. The average pore volume lost between a depth of 2.5 and 5 cm was 1.5%, and below, 5 cm, less than 1%. The volume of accumulated sediment was 23% in the upper 2.5 cm, 5.5% between the depths of 2.5 and 5 cm, and less than 0.5% below 5 cm. These data agree with the data obtained from the radiotracer study.

Even though the material above 2.5 cm accumulated a large amount of sediment, porosity was maintained by freezing and thawing, and wetting and drying. Infiltration rates of the basin have not been noticeably reduced. The success of excavated basins for recharge of