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REGULATION OF SUBSURFACE DISPOSAL IN TEXAS

An injection well is defined in the Texas Injection Well Act as an artificial excavation made for the purpose of injecting or disposing of industrial and municipal waste into subsurface strata. Industrial and municipal waste is defined as any liquid, gaseous, solid, or other waste substance which might be expected to cause pollution of fresh water.

Before any person may begin the drilling of an injection well or converting any existing well into an injection well for the purpose of disposing of industrial or municipal waste, a permit must be obtained from the Texas Water Quality Board, and a fee of $25 must accompany the application. A permit for drilling of an injection well to be utilized for disposal of waste arising from the production of oil or gas must be obtained from the Railroad Commission of Texas.

An application to the Board for a permit or waste-control order must be accompanied by a letter from the Railroad Commission of Texas stating that the well will not endanger any oil or gas resources. The Water Quality Board also is required to send copies of each application and subsequent waste-control order to the Texas Water Development Board, the Texas State Department of Health, and the Texas Water Well Drillers Board. The Act does not require a public hearing on the application, but the Board may hold public hearings if it is deemed in the public interest. The Board chose to hold public hearing and has adopted rules and regulations outlining the procedure.

The technical staff of the Board reviews each application for completeness, and assures that the proposed project is properly designed and that the reservoir is capable of receiving the waste without undue pressure increase. The staff makes recommendations for approval or denial of the waste-control order.

A waste-control order to drill an injection well may be granted by the Water Quality Board when it has been determined that this method of disposal has less effect on the environment than alternate methods of disposal, the well will not impair any existing rights, and that both groundwater and surface waters can be protected from pollution. The waste-control order contains provisions and requirements deemed necessary to protect fresh water.

The staff of the Board observes certain phases of the well completion, certifies the project upon completion, and conducts periodic inspections. The permittee must submit periodic reports on the wellhead injection pressure, and the volume and quality of the waste injected.

Penalties are provided, not to exceed $1,000 for each day of noncompliance with provisions of the permit. In cases of noncompliance, action may be brought in any court of competent jurisdiction, and at the request of the Texas Water Quality Board, the Attorney General of Texas may institute and conduct a suit in the name of the State of Texas.

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COMPATIBILITY OF INJECTION FLUIDS WITH RESERVOIR COMPONENTS

Deep-well disposal of wastes has proved to be feasible in certain geologic areas. The success of such an operation depends on a thorough investigation of all pertinent parameters before starting fluid injection. Possible interactions of waste fluids with reservoir fluids and rocks are among factors that should be understood.

Possible reaction between formation water and injection fluid may require that buffer solutions be used to help prevent the development of precipitates. Such precipitates can cause plugging of pore spaces to reduce rock permeability.

Some formations contain clays that may swell or migrate when contacted by foreign solutions. Subsequent bridging of the migrating clays at flow restrictions may cause severe plugging of natural flow channels and shorten the useful life of the well. Proper pH control of injected fluid can minimize clay migration. It would also be desirable to maintain chemical composition of the injection fluid as constant as possible at all times.

In some instances, injection fluid will react chemically with the reservoir rock and could eventually result in a plugging action. The effect of precipitates on injectivity will depend on flow geometry of the reservoir, with matrix permeability being more seriously affected than fracture permeability. Thus, an operator must be selective in the type of formation into which any waste is injected. As there are many reservoirs having decided variances in composition and properties, and even more types of wastes to dispose of, it is mandatory to investigate thoroughly each specific combination before injection is started.

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NATURAL AND INDUCED FRACTURE ORIENTATION

Natural fractures in rocks comprise: (1) joints which are commonly closely spaced, are of limited linear extent, and have negligible tangential displacements; and (2) faults across which opposite blocks have tangential displacements ranging from millimeters to tens of kilometers. Induced fractures are principally those produced in surrounding rocks by fluid pressures applied within well bores.

The orientation of fractures with respect to applied stresses may vary widely, depending upon the amount of finite strain the rock has experienced after the fractures were formed. The present discussion is limited to fractures in rocks that have experienced only minor strain subsequent to the fracturing.

In virtue of the fact that rocks are elastic solids, there exists in three-dimensional space beneath the surface of the ground a field of stress definable at each point by three mutually perpendicular principal compressive stresses and by the space orientation of these stress axes. On the three planes perpendicular to the principal stresses, shear stresses are zero; on all other planes, if the principal stresses are unequal, nonzero shear stresses exist.

Parallel with the ground surface the shear stresses must be zero. Hence, at each point of this surface, one of the three principal stress trajectories must terminate perpendicularly. Therefore, in regions of gentle topography and simple structure the underground stress field is usually characterized by a system of principal stress trajectories one of which is nearly vertical and the other two nearly horizontal.

When rocks are subjected to compression under unequal triaxial stresses, for certain stress combinations failure by fracture and tangential slippage occurs. Usually, conjugate sets of slip surfaces are formed whose lines of intersection are parallel with the intermediate axis of stress and whose acute angle (commonly about