

DEEP WELL DISPOSAL OF INDUSTRIAL WASTES IN INDIANA¹

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The destruction of our water resources, both surface and subsurface, by contamination and pollution is a national problem that has attracted wide interest. Currently, the management of water sources and all of the ramifying implications are being studied by industry, local, state, and federal government agencies, colleges and universities, and the general public. This national demand for clean waters has required industry to investigate all potentially feasible methods of wastewater treatment and disposal.

Deep well disposal systems are a rather recent technique adopted by industry for wastewater disposal. For many years, however, the oil and gas interests have been utilizing return wells for increasing oil and gas field yields as well as for waste disposal. As of January, 1966, there were seven industries in Indiana that operate deep well injection systems for the disposal of industrial wastewaters and one well is under construction. Recent approval has been given for three additional projects.

In 1957, the Indiana General Assembly amended the Indiana Stream Pollution Control Law for the purpose of including the subsurface water of Indiana within the jurisdiction of the Indiana Stream Pollution Control Board. Section 16 of the Stream Pollution Control Law (3) reads, in part, as follows: "Wherever the words water or waters shall be used in this act, they shall be construed to mean and include . . . underground water and any and all other surface and sub-surface water courses, underground reservoirs and basins . . ."

This amendment to the Stream Law has been interpreted to mean that the Board shall have the authority to control and prevent the pollution of ground waters. Prior to 1957, no statutory authority for control of subsurface waste disposal existed other than the Rules and Regulations of the Division of Oil and Gas, Indiana Department of Natural Resources (2) and the Public Health Code of Indiana (4). Currently, the Division of Oil and Gas continues to process the permits for subsurface disposal of salt water, sulfur-bearing water and other waste liquids

resulting from oil and gas well drilling and production operations.

All projects for subsurface disposal of wastewaters, other than those resulting from oil and gas ventures, are required to be submitted to the Control Board for review and approval in accordance with Section 10 of the Stream Law (3). Section 10 reads as follows: "That all plans and specifications for abatement or correction of any polluted condition shall be approved by the Stream Pollution Control Board. The Stream Pollution Control Board shall advise and consult, on request, with any person planning any correction or prevention of any pollution condition of any water of this State."

Since the 1957 amendment to the Stream Law, the Board has approved eleven industrial waste disposal projects which utilize deep well injection systems. Prior to 1957, only one known industrial waste disposal project utilized injection well techniques in Indiana. These systems utilize disposal horizons located between 70 feet and 6,160 feet below the earth surface. A brief description of these well operations follows.

Company No. 1. This company is located on the southern shore of Lake Michigan and its chief product is aluminum silica oxide catalyst. The plant's wastewater effluent is about 300 gpm and contains primarily sodium sulfate. Two injection wells about 1000 feet apart have been constructed for disposal of industrial wastewaters. The first well was developed in 1951 with a 295 foot deep disposal horizon and the second well was developed in 1953 with a 256 foot deep disposal horizon. The 256 foot deep well is utilized as an alternate or back-up facility to the 295 foot well.

The disposal horizon fluids, 50 mg/l of hydrogen sulfide and 4,000 mg/l of sodium chloride, had a higher concentration of salts than the industrial wastewater. Thus the company considered that the formation was a logical selection for waste injection. Since the contaminants are in solution and no reaction between the wastewater and the disposal horizon fluids was anticipated, the company did not provide pre-injection treatment.

Injection pressures are reportedly in the range of 50 psi. Continuous automatic monitoring of well head pressures is practiced to guard against forma-

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tion failure. The company has not experienced any operating difficulties.

Company No. 2. This company is involved in government contract chemical production and its products are classified. Hundley and Matulis (1) reported in 1962 on the conception and development of this injection well system. The wastewaters have a pH of 10 or greater and between 1,000 to 2,000 mg/l of suspended solids. The flow rate is approximately 100 gpm.

The Board approved the construction of a 6,160 foot deep well and the St. Simon formation was utilized as the disposal horizon. Fluids contained in the disposal horizon had the following analysis: pH, 4.9; Calcium, 2.2% (22,000 mg/l); Iron, 0.9% (9,000 mg/l); and Magnesium, 0.3% (3,000 mg/l). It was anticipated that a precipitate would form when the wastewaters and disposal horizon fluids mixed. Therefore, 2,000,000 gallons of buffer water was pumped into the disposal horizon prior to waste injection. Well head pressures are about 1,200 psi.

Pre-injection treatment consists of pH adjustment, sedimentation and filtration. Well head pressure and the specific gravity of the injected wastewaters are recorded to detect changes that might alter the usability of the well. The company has not experienced any operating difficulties.

Company No. 3. Food processing is the field of operation of this company and the well is used for the disposal of cooling waters. Operating data is as follows: Flow, 100 gpm; Contaminant, heat (80° F.); Well depth, 70 feet; Pre-treatment, none; and Well head pressure, 10 psi. The company has not experienced any operating difficulties.

Company No. 4. The field of operation of this company is chemicals and again the well is used for disposal of cooling waters. Operating characteristics are: Flow, 30 gpm; Contaminant, heat (75° F.); Well depth, 100 feet; Pre-treatment, none; and Well head pressure, 25 psi. The company has not experienced any operating difficulties.

Company No. 5. This company is engaged in the finishing of steel products and has about 60,000 gpd of waste pickling acid. The plant is located on the southern shore of Lake Michigan. The waste contains 6-10% sulfuric acid and 14-18% ferrous sulfate.

The injection well has a total depth of 4,300 feet and the injection tubing terminates at approximately 2,300 feet. The formation utilized is the St. Simon sandstone and well head pressures are about 100 psi at 275 gpm flow rate. Annulus fluids are monitored to protect against well failure. Pre-injection treatment consists of dilution to maintain ferrous sulfate and the company maintains surface neutralization

facilities as an alternate in the event of well failure.

Formation fluids contained about 40,000 mg/l of sodium chloride and between 6,000 to 7,000 mg/l of calcium. Approximately 35,000,000 gallons of buffer water has been pumped into the disposal horizon. The company experienced an injection tube failure during the spring of 1965; however, all necessary repairs were made in less than 24 hours.

Company No. 6. Also engaged in the finishing of steel products, this company likewise has waste pickling acid that requires treatment. Approximately 1,000,000 gallons per month of 6-10% sulfuric acid and 14-18% ferrous sulfate wastes are generated. The plant is located on the southern shore of Lake Michigan.

The injection well has a total depth of approximately 4,300 feet, and the injection tubing terminates around 2,200 feet. The Mt. Simon formation is utilized and well head pressures are less than 800 psi at 100 gpm flow rate. Facilities similar to those utilized by Company No. 5 are installed for pollution control in the event of well failure. Formation fluids and buffer water injection procedures are similar to Company No. 5. The company has not experienced any operating difficulties.

Company No. 7. This steel products manufacturer utilizes two injection wells both similar to those of Companies No. 5 and No. 6 for the disposal of 6,500,000 gallons per month of waste pickling acids. The waste contains 8-37% sulfuric acid, 18-25% ferrous sulfate and 2-6% chromic acid. The plant is also located on the southern shore of Lake Michigan.

The disposal horizon is the Mt. Simon formation. Well depth is about 4,800 feet. The company will have safeguards for the well systems similar to Companies No. 5 and No. 6 with the exception that the second well will serve as a back-up facility for pollution control in the event of well failure. The company plans full-time operation of the disposal system in June, 1966.

Company No. 8. This company is engaged in the refining of oil and the plant is located in Posey County along the Ohio River. An injection well is used for disposal of 6,300 gallons per month of spent caustic containing 0.1 pound per gallon of sulfides and mercaptides of sodium and some phenol. The injection well has a total depth of 2,400 feet into the Hardinsburg formation. No pre-injection treatment is employed in the disposal system.

Company No. 9. The company is a medical clinic located in western Indiana and the well will be used for disposal of air conditioner cooling water. Operating characteristics are: Flow, 120 gpm; Contaminant, heat (103°F); Well Depth, 120 feet; and Pre-treatment, none.

Company No. 10. This milk processing plant is located in northern Indiana and the well will be used for disposal of refrigeration cooling water. Operating characteristics are: Flow, 10,000 gpd; Contaminant, heat (100°F); Well Depth, 100 feet; and Pretreatment, none.

Company No. 11. This is a chemical plant located in southern Indiana and the well will be used for disposal of 57,600 gpd of phenolic wastewater. The well will be 2,790 feet deep and the disposal horizon will be the Bethel Formation. All wastewater will be pretreated in a pressure-leaf filter and the pH adjusted prior to injection. Maximum well head pressures are calculated to be 1,050 PSIG. Standby facilities will consist of two 3-acre absorption lagoons.

The engineering staff of the Stream Pollution Control Board collaborates with geologists from the Indiana Department of Natural Resources and the Indiana Geological Survey to ascertain whether or not a proposed injection well system will provide reasonable protection of ground resources. Only uncontaminated cooling water discharge is permitted in shallow formations.

Based on experiences with the above-described operations, the following conclusions can be made:

1. Deep well injection systems are being used successfully for disposal of certain types of industrial wastewater.

2. Pre-injection treatment consisting of pH adjustment, sedimentation and filtration may be required to maintain effective operation of the disposal system.

3. Shallow formations cannot be used for disposal of contaminated wastes.

4. The Mt. Simon formation appears to be the best formation for disposal of industrial wastewater in the state of Indiana.

5. No major operation difficulties have been encountered during operation of the disposal systems.

REFERENCES

1. Hundley, C. L. and Matulis, J. T., Deep Well Disposal. Proceedings of 17th Industrial Waste Conference, Purdue University, 1962.
2. Indiana Dept. of Natural Resources, Rules and Regulations Affecting Oil and Gas Operations, Chapter 277, Acts of 1947; amended by Chapter 137, Acts of 1951.
3. Indiana Stream Pollution Control Law, Chapter 214, Acts of 1943; amended by Chapter 132, Acts of 1945; and amended by Chapter 64, Acts of 1957.
4. Public Health Code of Indiana, Chapter 157, Acts of 1949, as amended; Sections 1750 through 1763.

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For further information, write to the Agricultural & Sanitary Chemicals Department, Rohm and Haas Company, Independence Mall West, Philadelphia, Pennsylvania 19105.