TASK 45 – FIELD DEPLOYMENT EVALUATION OF THE FREEZE–THAW/EVAPORATION (FTE®) PROCESS TO TREAT OIL AND GAS PRODUCED WATERS

Final Report

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DISCLAIMER

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TABLE OF CONTENTS

FIELD DEPLOYMENT EVALUATION OF THE FREEZE–THAW/EVAPORATION (FTE®) PROCESS TO TREAT OIL AND GAS PRODUCED WATERS

1.0 INTRODUCTION

Evaporation ponds are used for produced water disposal in arid climates of the United States and Canada. Low construction and operating costs make them an attractive choice for natural gas producers. They are limited however, because they are effective only when seasonal temperatures and climactic conditions promote evaporation.

The freeze–thaw evaporation (FTE®) process addresses the problem of seasonal usage by coupling evaporation with freezing. This offers operators a year-round method for treating produced water. Treating water with the FTE® process reduces the volume of water to be disposed of as well as purifying the water to a level acceptable for watering livestock and agricultural lands. This process is currently used at two evaporation facilities, one in the San Juan Basin in New Mexico and one in the Green River Basin in Wyoming.

1.1 The FTE® Process

The basic concept of the FTE® process is simple. Constituents in produced water lower the freezing point below that of pure water. When such a solution is cooled below 32°F, relatively pure ice crystals form, along with an unfrozen brine solution that contains elevated concentrations of salts. Because of the brine's high concentration of these constituents, its density is greater than that of the ice, and the purified ice and brine are easily separated. Coupling the natural processes of freezing and evaporation makes the FTE® process a more cost- effective and efficient method for the treatment and disposal of produced water and allows for year-round operation of an FTE® facility.

The FTE® process operates in the following manner: When the ambient temperature drops below 32°F, produced water is automatically pumped from a holding pond and sprayed onto a freezing pad. The freezing pad consists of an elevated framework of piping with regularly placed, upright, extendable spray heads similar to those used to irrigate lawns. As the spray freezes, an ice pile forms over the elevated framework of pipes, and the brine, with an elevated constituent concentration, drains from the ice pile. The high-salinity brine, identified by its high electrical conductivity, is separated using automatic valves and pumped to a pond where it can subsequently be disposed of by conventional methods. As the ice pile increases in height, the sprayers are extended. When the ice on the freezing pad melts, the relatively pure water is pumped from the freezing pad and discharged or stored for later use. No new wastes are generated by the FTE® process.

1.2 FTE® Commercial Deployments

1.2.1 San Juan Basin

Research sponsored by the Amoco Production Company, Gas Research Institute (GRI), and the U.S. Department of Energy has been conducted since 1992 to develop a commercial FTE® purification process for produced waters. Numeric process and economic modeling, as well as the laboratory-scale process simulation that confirmed the technical and economic feasibility of the process, was performed by B.C. Technologies, Ltd., and the University of North Dakota Energy & Environmental Research Center (EERC) from 1992 to 1995. They then conducted a field evaluation from 1995 to 1997 in New Mexico's San Juan Basin at a conventional evaporation facility operated by Amoco Production Company. The results of this evaluation confirmed that the FTE® process has significant commercial economic potential. A new facility was designed in 1998, and its construction is expected to begin in 1999.

1.2.2 Green River Basin

B.C. Technologies, Ltd., the EERC, and GRI are currently involved in a commercial deployment at the Jonah field in the Green River Basin in southwestern Wyoming. In February 1998, the Wyoming Oil and Gas Conservation Commission approved the FTE® operation, and within weeks, freezing pads and spray equipment were added to the existing evaporation facility operated by McMurry Oil Company.

The commercial deployment operation of the FTE® process began at the end of February 1998. While the late start date and warm spring severely limited throughput to the freezing process, the FTE® plant was successfully operated at temperatures below -20°F, and treated water of a quality suitable for beneficial uses was produced. This was encouraging, considering a positive net production of ice was possible for only 2 weeks of operation, climatic conditions did not allow for aging of the ice pile, and the feedwater was predominantly from the "frac flow-back," which is more difficult to treat than conventional produced water.

Following the ice melt, the FTE® facility operated in the evaporation mode. In spite of an unusually wet summer, a net 23,500 barrels (bbl) of water was evaporated. Two additional brine ponds were added to the project in November 1998, and an FTE® deployment freezing operation began in December 1998 that will continue through the winter. The creation of two ice piles in excess of 40 feet in height is expected.

The current cost of disposal at this field when the FTE® process is utilized is approximately $1/bbl. Commercial facilities in southwestern Wyoming are charging as much as $6/bbl for produced water disposal. The cost of disposal varies according to disposal fees, which are generally used to maintain the facility, and the distance required to transport the produced water from the production site to the disposal facility. Weather conditions also contribute to the cost of transportation.

2.0 CONCLUSIONS

In conclusion, the FTE® process has a definite economic advantage over conventional evaporation technology in climates with seasonal subfreezing ambient temperatures. Since the process requires essentially the same equipment as conventional evaporation, it allows more water to be processed in an evaporation facility by operating at times of the year when evaporation is ineffective.

Technically feasible and capable of processing high-quality water suitable for the wide variety of beneficial uses cited previously, the FTE® process could also be applied to treating oil and gas residuals found at refinery or gas treatment plants and bases, and to wastewater generated at food-processing plants.