# Turnkey Waterflood Installation

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A successful waterflood operation can be divided into three major parts: (1) a reservoir that can be economically flooded, (2) a source of water that can be used without untold cost, and (3) the means of injecting this water into the formation.

This article will deal with the injection equipment, but for a background, the other two phases will be briefly discussed.

The location of the unit, which was designed and installed by Mid-Continent Supply Company and is operated by Hiawatha Oil & Gas Company, is located 20 miles southeast of San Angelo, Texas. The Formation to be flooded is the Canyon Sand and is 3900 ft. deep, having an average permeability of 2.2 MD and 13 per cent porosity.

The water well was drilled to a total depth of 6000 ft and is producing from the Cambrian Formation. This water is very corrosive and has 112,000 parts solids, 446 parts carbon dioxide, 36 parts iron, and a temperature of 138° at the supply well head. It is pumped with a 100 hp submerged centrifugal pump set at 2000 ft and capable of producing 5500 BPD.

A study of the unit was made by an independent engineering firm, and the firm reported to the operators the recommendation that water be injected into 16 existing wells and that production be made from the remaining 30 wells in the unit. It was also recommended that a basis for sizing the unit would be a total of 6000 BWPD at 1000 psi.

The first step taken in preparing for a turnkey operation was to plan the distribution system so that a plant site could be chosen. It can be noted in Fig. 1 that the plant site is between two parallel trunk lines, is adjacent to a paved road, and is on the same location with the water supply well. The distribution system was sized to keep the pressure drop to a minimum, and it can be seen from the layout in Fig. 1 that the maximum drop is 37 psi at Well 7. At the "T" where the system leaves the plant, there is a 4 in. valve on each side so the pressure can be shut off on either side of the field. Also on each side of the "T" where the main lines from the plant join the trunk lines, there are valves, by the use of which, the system can be shut in by halves or quarters and have four wells per quarter. The piping for this system is 4 in., 3 in., and 2 in.

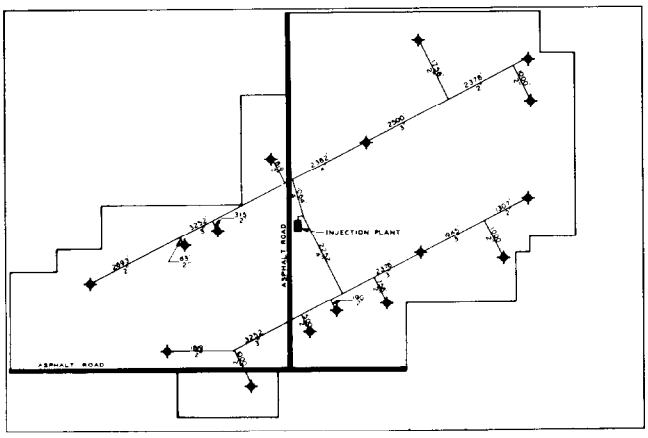


Fig. 1. The injection system and plant location.

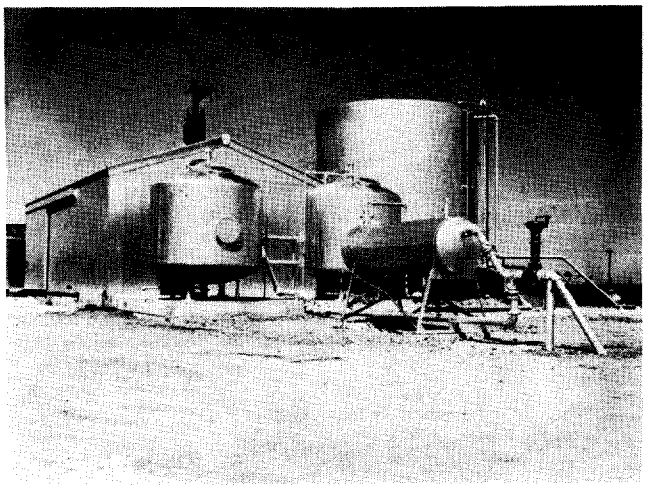

Photo 1. Outside view of the injection plant showing the separator, filters, clear water tank and building.

The next step in the operation was to plan an over-all layout of the plant site, to size equipment that would be needed to meet the requirements, as set up for the present time, and also to plan ahead for enlarging the plant at a later date. Fig. 2 shows the plant site layout. In the drawing, the water well is located in the upper right-hand corner. From the well, the water flows directly into a horizontal separator which was installed in the line to take out the carbon dioxide gas and still maintain a closed system. It can be noted that provisions have been made to install a 1000 barrel raw water tank at a later date if it will be felt that one will be needed.

Installed in the line between the water well and the separator is a diaphragm operated choke valve to control the rate of flow from the water well. This operation is performed by a hydrostatic head control in the clear water tank. As the water in the tank nears the top, the valve will partly close and restrict the flow. This restriction in the line will create a more favorable and economical operating condition for the supply pump.

Still under pressure from the source well pump, the water leaves the separator, and the pressure will carry the water all the way to the clear water tank where it will enter the filters. These filters are 5 ft by 8 ft sand and gravel type and are manifolded in such a way that water may be filtered through both filters at the same time or one or the other may be cut out. This process also applies to back washing: one at a time or both at once. Further, the back wash system is manual, and the pump is located inside the building.

Filtered water then enters the clear water tank. The 18 ft. by 20 ft. 1000 barrel welded steel tank with cone bottom and syphon drain was set on a 4 ft. mound so that the outlets would be level with the injection pump's suction; thereby, giving them a flooded suction at all times.

Piping from the tank to the pumps is direct and level, and eliminate the need for a suction manifold. Also, by

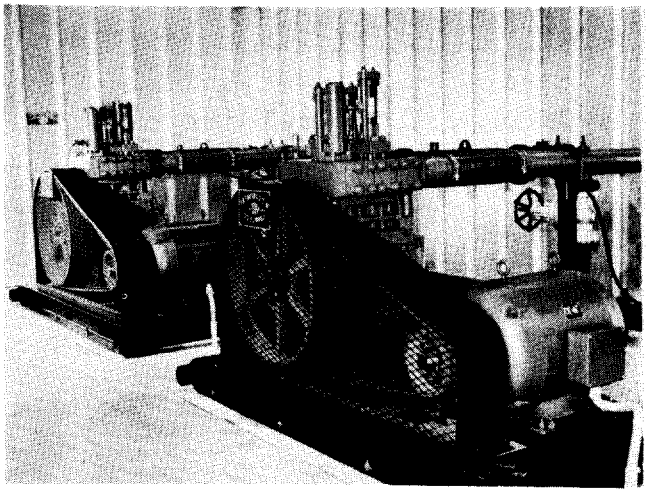

Photo 2. This photo shows the two four in. vertical triplex plunger pumps powered by two 60 hp electric motors.

turning the pump suction toward the tank, one is able to install a suction without the use of ells. At this point, it can be noted that provisions were made for adding another pump if an addition should ever become necessary.

Initial operating design conditions called for 6000 BPD at 1000 lb psi with a maximum pressure rating of 1450 lb psi. Two 67 hp, 4 in. stroke vertical triplex plunger pumps, mounted on oil field type skids and powered with electric motors, were chosen for this project. Each pump is equipped with a flow thru, air filled, pulsation dampener. The discharge manifold was prefabricated in a machine shop, and welded fittings and flanges were used. This prefabrication enabled the complete discharge system to be coated with baked-on type plastic before the system was taken to the job site. It can also be noted from Fig. 2 that the discharge and suction lines are placed in such a way in the building that, in the normal operation of the plant, the operator will not be required to step over any pipes.

Control of the entire unit is from a central panel located in the building. The tank is equipped with three diaphragm type hydrostatic head switches. One is located 18 in. from the overflow and acts through the control panel to stop the water source well pump. Another is located 5 ft from the bottom of the tank and acts to start the water source well pump. The third is located 3 ft from the bottom of the tank and will act to turn off both injection pumps if the water should reach this point; thus it will prevent the pumps running with a dry suction. An air operated disphragm choke valve is incorporated into the discharge manifold to return to the tank the excess volume of water produced by the injection pumps. The control for this valve is also located on the central panel which also includes a number of safety devices that will protect the unit by shutting down one or both injection pumps and by sounding an alarm siren that, day or night, can be heard for at least a mile. Also on the panel are a number of lights and tattle tale buttons that will show the operator at a glance what caused a shutdown. Too, each pump has individual safety shutdown controls for low oil pressure and high oil temperature. And both pumps will shut down because of high or low discharge pressure or low level in the supply tank.

Because of the very corrosive water used in this project, there was designed a complete closed system with protective coatings used throughout: the supply and injection lines are cement lined; suction lines from the tank and discharge manifold have baked on plastic; the tank and filters are protected with coal tar epoxy; the storage tank is also equipped so that a gas blanket could be maintained at all times.

Each of the 16 injection wells is equipped with a well head filter, throttling and shut off valve, meter, and pressure gauge.

Mid-Continent Supply Co. believes that the turnkey installation is the most satisfactory and economical route for the operator to take in his efforts to waterflood his unit.

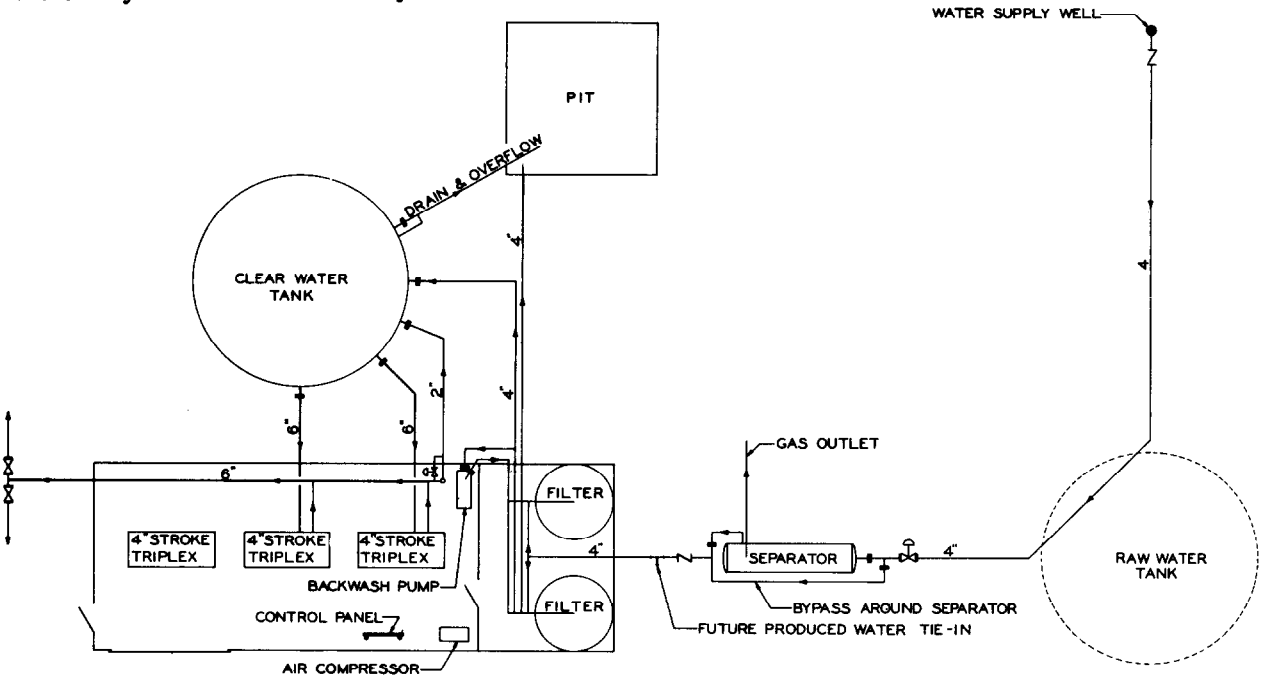


Fig. 2. General Plant layout.