SOME DESIGN CONSIDERATIONS FOR GRAVITY OR LOW PRESSURE SALT WATER DISPOSAL SYSTEMS

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ABSTRACT

The disposal of produced water is an integral part of the oil producing operation. Various methods of disposal have been utilized over past years, however, strict anti-pollution laws prohibiting surface disposal and the high cost of trucking water have narrowed the options. On-lease disposal by pipeline into company or cooperative disposal systems is the most efficient and economical solution. Proper design of the disposal system should be given due consideration and planning to minimize the cost of disposal and to insure the life of the disposal system.

INTRODUCTION

In recent years the disposal of produced water has become a more complex and more expensive problem for the oil producer. With the introduction of "no pit" orders subsurface disposal became the only real solution for disposal. A number of commercial disposal wells were completed to handle water which was trucked from the producing lease to the disposal site. In other instances, on-lease disposal through pipelines into disposal wells located in the immediate area was the most economical method of disposal. The increased cost of trucking in recent months has made this method of disposal prohibitive in some instances and placed renewed emphasis on the consideration of on-lease disposal by pipelines.

The purpose of this paper is to discuss some design considerations for an integrated salt water disposal system. A primary consideration in the design of any disposal system should be the utilization of gravity to gather and dispose of the water, and especially so in our area of West Texas and Southeast New Mexico. Gravity is free energy, it costs nothing, and is generally an available tool in this area due to the flat, sloping topography.

A disposal system may logically be separated into three components, i.e., disposal wells, accumulation or terminal facilities and gathering lines.

DISPOSAL WELLS

The disposal well is the most vital part of the system and should be carefully selected and completed. There are a number of zones that will accommodate water by gravity injection and these should be considered first and foremost. Where large volumes of water are produced from a reservoir, that formation, in general, should have the characteristics required for good disposal and should accept water by gravity flow. The distance from the surface to the static fluid level in a well will determine the available head for gravity injection.

Since pumps and power are expensive tools they should be avoided, if possible, and especially where large volumes of water are present or expected. Whereas, in some instances, good disposal zones are at greater depths and deep disposal wells are expensive to complete, extended cost analysis will generally show that the deep disposal well is still the most economical solution over the life of most producing fields.

Where possible, it is usually more desirable to utilize an abandoned oil well that has casing already cemented or, at least, a dry hole that has been drilled to the proper depth. In selecting the well location consideration should be given to the topography and the well located such that all water being gathered will flow by gravity to the disposal well site.

As soon as possible after completion of the disposal well an accurate injection test should be taken to determine the capacity of the well so that the tubing and surface equipment can be properly designed and selected.

TERMINAL FACILITIES

Accumulation or terminal facilities should be installed at the disposal well to provide for the settling of suspended solids and the accumulation of oil, to allow for fluctuations in water production and to permit periodic testing of the well. If adequate tank capacity is provided and the flow properly dispersed, no other terminal equipment may be required.

An inlet spreader designed to reverse and slow the flow into the terminal tank should be utilized for large volume installations. An outlet boot arrangement or siphon leg should be designed for the outlet of the tank to prevent oil and floating solids from entering the well. A tank float and/or control valve should be used to control the fluid level in the tank. Where pressure injection is necessary, electrical devices will have to be substituted to control the fluid level in the tank. All equipment selected should be coated or of non-corrosive material because of the corrosive nature of most produced water.

Generally the tank facility can be designed as a semienclosed system. The water in the terminal tank will carry a floating oil seal and the gas escaping from the oil and water will provide a gas blanket.

GATHERING LINES

The water gathering lines should be designed to take advantage of gravity and the natural drainage pattern in the area. The lines should be surveyed and profiled to determine their lengths and elevations which are important to the design of the gathering system. Even though gravity gathering lines will necessarily be larger than would be required in a pressured system, about the only significant additional expense involved will be the cost of the pipe since ditching and laying costs will be only slightly higher. This higher initial cost expended for a gravity system will be more than compensated for by lower operating expenses over the life of the system.

Since a closed piping system is used, there is some latitude in the design of the gathering lines. Lines may actually go uphill for short distances but generally the lines should be laid to grade for the best performance. The lines should be graded to approximately 2'/1000', where possible, for the reason that it is difficult to install lines to a lesser grade without having minor variations in grade that cause capacity problems. These capacity problems are due to the stringing of oil and gas throughout the lines with questionable grading in the minor high and low variations which are present. Where high points are necessary in a line it should be adequately vented. It is important that oil and gas be kept out of the gathering system, particularly gas, because it can very effectively block a line.

Corrosion resistant materials should be considered for all gathering lines. The most common materials used are plastic and asbestos cement pipe. Heavy wall plastic, fiberglass reinforced plastic and lined steel pipe is best suited for rock terrain or near surface installations. Plastic pipe is particularly sensitive to heat and its application under such conditions should be carefully designed and installed.

It is recommended that a friction factor of C/100 as applied in the Hazen-Williams Formula be used in sizing the gathering system. All materials mentioned have a much smoother surface when new, but after being in service for any length of time will collect scale material on the pipe surface so that this original smoothness of the surface is changed. This does not mean that the higher original value of the C factor cannot be maintained but it becomes impractical and uneconomical to do so. Experience has shown that C/100 is the most practical friction factor to use in the design. Lines should be sized large enough to accommodate fluctuations in production from the leases they serve and to accommodate any additional development wells that might be added at a later date.

The design of the gathering system should incorporate facilities necessary to periodically inspect and clean the lines, i.e., valves and scraper traps. It is desirable to have these facilities located so they are accessible to trucks and crews that will be utilized for the inspection and cleaning operations.

CONCLUSION

Where a water disposal system can be installed to serve a number of leases or an entire pool, the per well cost can be held to a minimum by eliminating duplication of disposal wells and gathering lines. Where possible, the cooperative approach should be used.

A well designed system should provide as near continuous, uninterrupted operation as possible. Shutdowns of any kind, such as gas locked lines and inadequate line capacities, are time consuming and expensive to the oil operator.

Any salt water disposal system requires good engineering design, proper material selection and continual experienced supervision in order for the system to give efficient, economical operation throughout the life of the oil field.