Salt Water Disposal System - Design, Construction, and Operation

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A salt water disposal system is needed in an oil field to gather the waste product: salt water from the various leases and dispose of it in the most economical way below the surface of the ground. Usually a salt water disposal system is a joint effort to serve more than one party in a field and should be viewed in the same light as a gas gathering facility or a crude oil gathering system. Of course, oil field brine has no commercial value as do oil and gas and has to be classified as a waste product; and the disposal of this waste is strictly a liability or operational expense.

Usually the design and even the organization of a disposal system falls upon the district, area, or field engineer. As soon as the first well in a field is completed, the engineer should recognize the type of reservoir and alert his management of the future possibilities for subsurface disposal if this is warranted. Usually though, even the most prudent oil operator waits until substantial amounts of water are produced before the organization of a system is attempted.

First, the subject area should be delineated and a map prepared to show all the tank batteries with their ground-level elevations spotted on the map. The subject area should, if possible, be contiguous acreage and should outline the entire area to be served by the disposal system. To eliminate future pollution liability, it is best to include all of the operators and batteries in the outlined area. Second, the maximum water volume to be produced per well daily should then be decided upon. It is imperative that a realistic water figure per well be used in the design of a system. The initial cost of installing a 6 in. rather than a 4 in. line is small compared to cost of looping that line 2 or 3 yr hence. Bottom hole pressure, potential and productivity index tests may help the design engineer in deciding how much water each well will produce in the future.

At the same time that the above design problems are being solved, the problem of the disposal zone and well should be considered. If at all possible, the selection of a disposal zone which will result in a gravity flow disposal well should be made. Even though the initial completion cost may be much higher to secure a gravity disposal well, it will undoubtedly be cheaper than paying the pumping and operational costs that arise from a pressure injection well.

The disposal well falls into three categories: (1) A well drilled specifically for disposal service, (2) A dry hole converted for disposal and (3) An abandoned producing well which can be converted for disposal. A well drilled specifically for disposal can be located favorably to take advantage of certain geological conditions which may effect the injection characteristics of the well and at the same time be located geographically favorable to changes in ground elevations and battery locations. Also, of most importance is the fact that the selection of the hole size, casing and casing depth can be made before the well is drilled for this selection will effect the well's performance. The high initial cost of drilling a new disposal well is its principal disadvantage. A dry hole in which the casing has not been set has the advantage of being less expensive for disposal providing the surface location is suitable and the well bore large enough to accomodate the injection casing. An abandoned producing well offers the cheapest disposal well providing the casing is in good shape and it is located favorably, both geologically and geographically.

Now that all the basic design factors have been accumulated, it is a small task to arrive at the line sizes and location of the terminal facilities. A salt water disposal gathering system should always be designed for gravity flow for this is the easiest and cheapest way to move water. It is ridiculous to design a system in which pumps are required to force water into the gathering system at every tank battery connection. Of course, there may be systems that require transfer pumps to lift water for short distances but those incidents are inevitable in system design. Generally, the gathering system follows the drainage pattern of the ground surface and should be designed accordingly.

A C factor of 100 as applied in the Hazen-Williams friction formula should be used for designing the line sizes. Although a friction factor of over 100 is available with new pipe, whether it is asbestos-cement, plastic or cement-lined; after installation and use, it is not economically feasible to maintain a higher factor than 100.

It is best to specify gas boots to be used at all pressure treaters or water knockout vessels in order to keep gas out of the gathering system. Also, if it is impossible to vent the lines at the tank battery connection (either boots or siphons), it will be necessary to install vents. Regardless of precautions, gas accumulates in the gathering lines and will cause line blockage so the system should be designed to vent the gas before this blockage occurs.

Terminal facilities consisting of 1 or more tanks should be located adjacent to the disposal well. The capacity of this storage should be adequate to allow sufficient settling time for all suspended solids to drop out in the tanks and not be allowed to get into the disposal well. Also, some oil will accumulate on these tanks through poor treating facilities or human error and should be kept out of the injection well. The best arrangement to use in the accumulation tanks is a perforated spreader which disperses the incoming water and decreases its velocity so the solids will drop out. Also, an outlet boot in this tank can be installed to alleviate the possibility of oil being injected into the well.

Redwood tanks make an excellent accumulation facility for they are corrosion resistant and can be partially buried if the feet of head necessary for gravity flow is not excessive. Concrete tanks have been used but their construction is difficult and more costly. Steel tanks if adequately corrosion protected can also be used.

In the entire system, the selection of material should be carefully made to include corrosion resistant pipe, valves, tanks, vents and all fittings.

The design of salt water system should include facilities for scraping lines such as full opening valves, scraper traps and junction boxes. These facilities are necessary in order that any remedial work performed on the system can be done with a minimum of down time. Remember, the operation of a salt water disposal system is paid for by the oil and gas produced from the connected wells, not from the sale of salt water. Also, a system should be designed to serve all the producing wells in the subject area with a minimum of maintenance until the last producing well is plugged and abandoned.

The next important step in a salt water disposal system is the construction. After a contractor is selected either by choice or competitive bidding, all specifications, profiles, maps and materials should be carefully explained to the contractor's foreman that will be running the spread. In fact, the more information that is supplied to the contractor before the bid is let will help in receiving a better price for the job. Also, a contractor will bid a job to make a profit -- which he is entitled to make -- and any clarification of your specifications will tend to lower the risk for him and consequently will result in saving you money.

The construction of the system should be closely supervised by experienced personnel and a day-to-day progress report of the job submitted to the supervising engineer. Decisions about material to be used, design and inspections should not be the responsibility of the contractor on the job but should have been decided upon before the job was started. Any changes in the construction of a system which effect the basic design should be made by the supervising engineer and relayed immediately to the contractor.

The disposal well should be drilled, or, if the case may be, recompleted before the construction of the lines is started. An accurate injection test or tests, either by gravity or pressure, should be accurately performed on the disposal well at this time.

After the installation of a salt water disposal system, the operational phase begins. A system should not be forgotten for it is important that records must be maintained on disposal well volumes and injection pressures, remedial work and periodic inspections. Lines should be inspected for scale and paraffin deposition and gas vents should be cleaned regularly. Terminal facilities should be checked, sometimes daily, to determine the volume of waste oil that accumulates; and the storage tank or tanks should be cleaned if any solids, B. S. or iron sulfide deposits accumulate.

For economic operation throughout the life of an oil field, the salt water disposal system must be carefully designed, properly constructed, and maintained by experienced supervision.