EVALUATING PRESENT EQUIPMENT TO OBTAIN BETTER WATER QUALITY

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ABSTRACT

Properly prepared produced water can help eliminate the millions of dollars spent yearly on injection and disposal wells. Large holding tanks and wash tanks are often used as oil separators and water polishers throughout the industry. Evaluating the effectiveness of these tanks can be accomplished through the interpretation of a retention study and by reviewing analytical data derived from oil parts per million and millipore filter analyses.

The flow characteristics of the tank and the tank's effectiveness in removing oil and solids will aid in determining the type of internal design needed for better equipment utilization. This paper will deal with three ways of modifying water holding tanks and wash tanks economically to provide better water quality. The effective methods used in treating reclaimed oil and solids to provide saleable oil will also be presented.

INTRODUCTION

Providing and maintaining good water quality has become an essential part of the oil industry's operation in recent years. There are five primary reasons for effectively treating produced water: (a) an effective waterflood program, (b) reclaiming saleable oil, (c) a reduction in plugging tendencies in injection and disposal wells, (d) removal of solids resulting in a more effective corrosion and/or scale control program in water systems, and (e) good water quality essential to tertiary recovery programs.

Most produced waters contain free floatable oil, entrained oil, iron oxide, iron sulfide, clays, sand, and paraffin. Effective removal of these plugging agents is essential in properly preparing produced water for injection purposes. In most injection system locations, there are holding tanks and wash tanks available for oil separation and water polishing. The use of coagulation chemicals ahead of these tanks is an effective way of removing oil and solids and assisting in the polishing of produced water.

Care should be taken that the internal design of these tanks is such that a coagulation chemical cannot have adverse effects in regard to the plugging of injection systems. Before any chemical is used in a water system to improve water quality, the mechanics of the system must be evaluated. This paper will deal with methods of evaluating the equipment available to determine whether water clarification chemicals can be effectively utilized. In addition, information will be included on tank designs which can be beneficial in providing improved water quality.

DISCUSSION

Evaluating the available equipment is essential in order to determine its true effectiveness in oil and solids removal. Samples on the inlet and outlet sides of the tanks should be collected with millipore filter tests conducted and oil parts per million determined. This will provide background information as to what the present equipment is doing to remove free oil, entrained oil, and solids. It is advisable that numerous samples be collected over a period of time instead of relying on spot-checking.

Once the samples have been obtained and analyzed, the results of the tests will indicate the effectiveness of the equipment in removing the oil and solids. An indication of inadequate treating capabilities in a water tank are large amounts of free oil in the samples taken downstream of the tank. There may be visible signs of oil-wet solids, clays, and/or sand accumulated in the bottom of the sample containers. If free oil is visible on the outlet side of the water tank, there is a strong possibility of turbulence and very little retention time inside of the tank.

The presence of oil-wet solids, clays, and sand would be an indication of either turbulence inside the tank or the need for a physical cleanout of the tank to eliminate this carryover. The solids can accumulate over a period of years and build up on the sides and bottom of the tank. Consequently, these particles can wash off into the injection system.

Once the effectiveness of the equipment has been established, the next step is to run a retention study on the tank to determine the amount of retention time and whether it would be feasible to use a coagulation chemical to improve water quality. With a proper interpretation of the retention study, it can be determined if a chemical would be an improvement or a detriment in the water system. It can also provide information concerning the type of tank design necessary in order to acquire the desired retention time and provide good water cleanup.

RETENTION STUDY

It is the normal practice to determine the retention time in a tank by the amount of fluid going through the tank versus the size of the tank. This calculation does not take into account the actual flow of the fluid through the tank and does not represent a true retention time. In determining the correct retention time, a predetermined amount of traceable material should be injected immediately ahead of the tank. At least five samples should be collected at the tank outlet before the tracer is injected into the system to establish a base line.

After the tracer has been injected into the system, samples should be collected for a minimum of sixty minutes. The sample frequency can determine the exact time that the tracer travels through the system. Graphing the results by the amount of tracer versus time will indicate how much time is in the system and the amount of movement (short currents and dead spots) in the tank.

Figs. 1 and 2 are retention study graphs on two 5,000 barrels of water per day throughout on each. The graphs indicate that in five minutes some tracer came through the tanks; and at ten minutes, the maximum amount of tracer went through the system. This retention study curve represents very little use of these water tanks due to these short currents and less than ten minutes of retention time.

Table 1 gives the results of the effluent water leaving a 25,000 barrel tank. The oil carryover is 900 PPM with total filterable solids averaging 64 mg/l.

TABLE 1

DATE	OIL PPM	TFS MG/L
8/11	760	75
8/11	1000	
8/12	800	54
8/12	900	
8/14	1100	63
8/14	840	
8/17	830	
8/17	970	
8/20	1000	64
8/20	800	
AVERAGE	900	64

These results indicate that 8,212 barrels per year of saleable oil are lost and 102 tons of solids are injected into the ground every year. This is typical of most water tanks located throughout the Permian Basin. However, with simple and inexpensive modifications on any tank with similar results, a desirable retention time can be obtained and excellent water quality provided with a coagulation program.

TANK DESIGN

In reviewing Fig. 1 and Table 1, it was determined that this tank be redesigned in order to provide better retention time and improved water quality. This water tank's inlet and outlet were opposite each other with the inlet three feet off the bottom and the discharge one foot off the bottom. Both openings will not give sufficient time for free oil to rise to the tank's top. Solids which have accumulated over a period of time on the bottom of the tank are picked up since the discharge is situated so low. If a water clarification chemical had been used in this system, the plugging of injection wells would be greatly increased.

By evaluating the samples obtained which contained large amounts of free oil and some oil-wet solids, it was decided that the best and least expensive solution to this problem was to redesign this tank as shown in Fig. 3. This tank design will allow the free oil and oil-wet solids to remain at the top of the tank. The inlet and discharge spreader was placed across the entire width of the tank to provide fewer dead spots and better utilization of the entire tank. The water leg on the tank outlet must be used to keep the oil and water interface constant and above the top spreader. The space above the upper spreader should be fairly still and serve as the oil skimmer.

A very important aspect of any tank design is the position of the inlet, the outlet, and the mechanism used for skimming. Since the oil and solids will be skimmed off the surface above the upper spreader, the pipe must be large enough to accommodate the oil-wet slug that will accumulate. The water interface must stay above the inlet top spreader, and the skimmer can be placed so that the overflow of oil and solids can be skimmed daily. A sample point on the skimming equipment will make sure the interface is skimmed off and held to a minimum.

A retention study was conducted on this new design, and the results are illustrated in Fig. 4. At twenty minutes, the tracer came through the system with a gradual increase to forty minutes before a maximum concentration of tracer was reached. A gradual slope in the curve indicates a slow movement of fluid inside the tank.

Table 2 reflects the analytical results obtained after alterations. The average oil carryover is 130 PPM and the total filterable solids 28 mg/l. This is a drastic reduction of 7,026 barrels of oil per year and 58 tons of solids per year.

TABLE 2

DATE	OIL PPM	TFS MG/L
10-2	120	24
10-2	180	
10-4	135	31
10-4	120	
10-5	135	29
10-5	110	
10-8	145	35
10-8	115	
10-9	140	21
10-9	120	
AVERAGE	130	28

A review of the retention curve and a coagulation study indicated that this tank would be an excellent candidate for an effective oil and solids removal with a coagulation chemical. A coagulation chemical was injected at a concentration of 8 PPM ahead of the skimmer tank.

Table 3 indicates an excellent performance of oil and solids removal with the help of a coagulation chemical. The average oil carryover was 18 PPM and the average total filterable solids 8.1 mg/l. This is a reduction of 1,022 barrels of oil per year and 32 tons of solids per year with the use of a coagulation program. By redesigning this 5,000 barrel tank and using a coagulation chemical, 8,050 barrels of oil were recovered with a reduction of 89 tons of solids per year. The cost of the redesign and the coagulation program was offset through the sale of the reclaimed oil. Also, the plugging tendencies of the water was drastically reduced allowing a more efficient and effective waterflood operation.

TABLE 3

DATE	OIL PPM	TFS MG/L
10-15	24	7.7
10-15	18	
10-16	39	8.7
10-16	12	
10-18	9	8.0
10-18	8	
10-20	18	9.1
10-20	28	
10-25	10	7.9
10-25	16	
AVERAGE	18	8.1

The least expensive tank design which can be modified quickly is shown in Fig. 5. This tank is operating in the Permian Basin at this time and was originally an old gunbarrel in which the flume was cut, raised, and reassembled. There are some inadequacies in this design because the entire tank is not being utilized to its fullest extent. Clean water can be obtained with this tank design if the oil is fairly free, there are very little solids present, and there is a low volume of water throughout.

Fig. 6 is a tank design that we have been experimenting with over the past ten years. The incoming line at the top of the tank is at a 115 degree angle which directs the flow of the water around the walls of the tank. With the inlet line at this angle, there is a greater utilization of the sides of the tank. Consequently, the retention time will be greatly increased compared to Figs. 3 and 5.

If the effluent water contains a large amount of entrained oil, this type of design would be an asset in reducing oil carryover. The vortex motion inside the tank aids a coagulation chemical program in producing larger particle sizes through flocculation. The interface that accumulates at the top of the tank must be skimmed daily, as the vortex in the tank can draw the oil-wet solids down and create plugging problems in the injection system.

During the past ten years, we have been experimenting with numerous tank designs; and the three designs in this paper are very effective and widely used in the Permian Basin. These designs are merely ideas that have been put into practical use. There are numerous ways and methods of redesigning tanks in order to provide better retention time and cleaner water (i.e., baffles, gas rings, etc.). The type of design most effective for your field will revolve around the problems that presently exist and the quality of water desired.

TREATING SKIMMED MATERIAL

Effective skimming of oil and solids that have been extracted from the effluent water is a key to acquiring and maintaining good water quality. Handling these oil and solids can prove to be very costly and extremely difficult.

The skimmed material accumulated during the water treating process contains various types of chemical added throughout the producing process (i.e., downhole corrosion inhibitors, scale inhibitors, surfactants, emulsion breakers, etc.). Putting this skimmed material through the production treating equipment can cause severe problems in producing saleable oil. UNDER NO CIRCUMSTANCES SHOULD ANYTHING FROM THE WATER TREATING SYSTEM BE PUT BACK INTO THE PRODUCTION TREATING EQUIPMENT. THE SKIMMED MATERIAL MUST BE KEPT IN A CLOSED SYSTEM AT ALL TIMES. There are basically two different ways of handling this problem.

Seperate Treating Equipment

This is one of the most popular and most effective methods used. An old heater treater or old gunbarrel can be put back into service to be used to treat skimmed material isolated from the regular treating equipment. For this type of treatment, a water bath in the treating vessel must be maintained and replaced periodically. A very small amount of chemical (preferably an oil soluble surface active product) can be used to provide saleable oil.

Additional Run Tank or Settling Tank

Isolating the oil and solids in a separate run tank or settling tank is another method of handling this problem. Free water can be removed from these tanks and the oil gradually mixed with pipeline oil. This may raise the BS&W slightly, and care should be taken that pipeline specifications for saleable oil are met.

SUMMARY

In most cases, redesigning equipment is necessary to aid a chemical program in obtaining the water quality specified by oil producers. With a successful water clarification program, oil can be reclaimed for sale and plugging materials decreased. These advantages will be profitable by saving millions of dollars spent yearly on injection and disposal well workovers.

ACKNOWLEDGEMENTS

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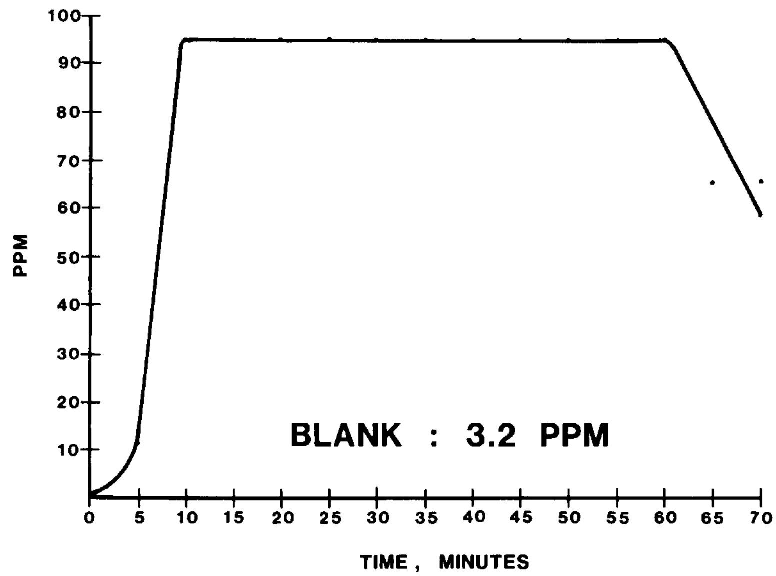
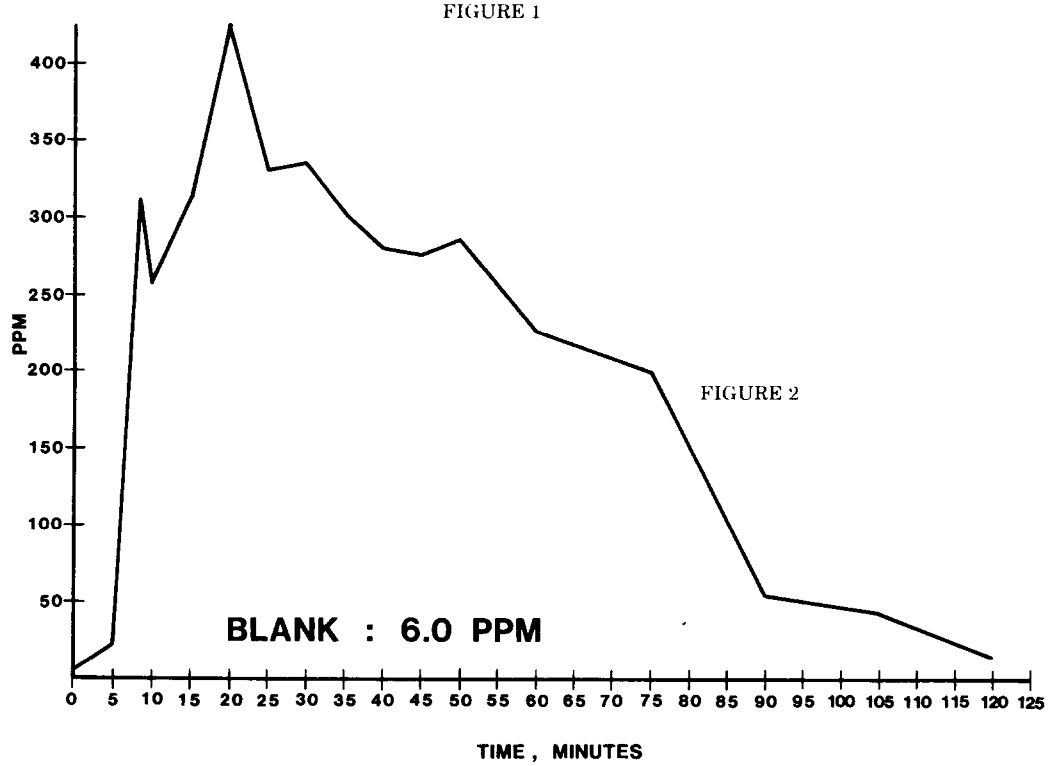


FIGURE 1



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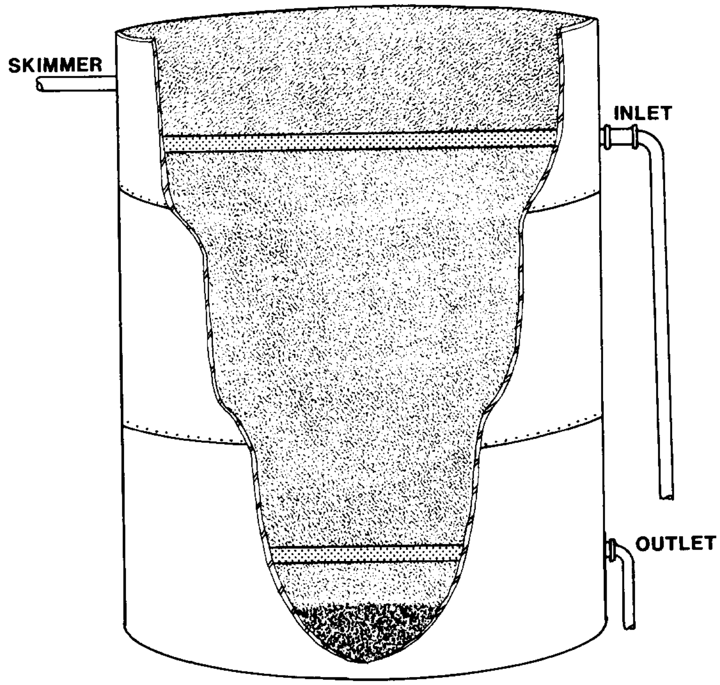

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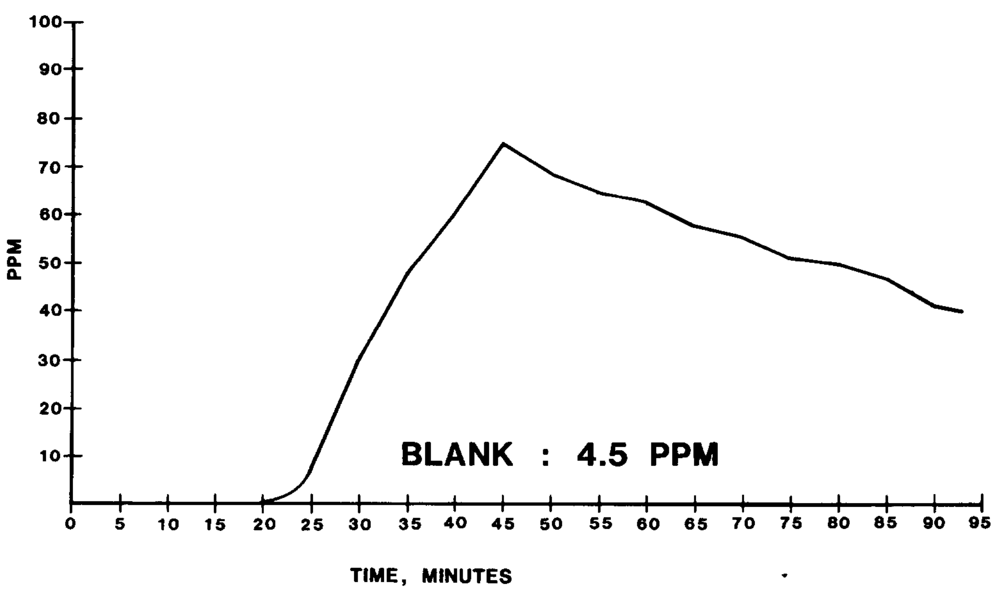

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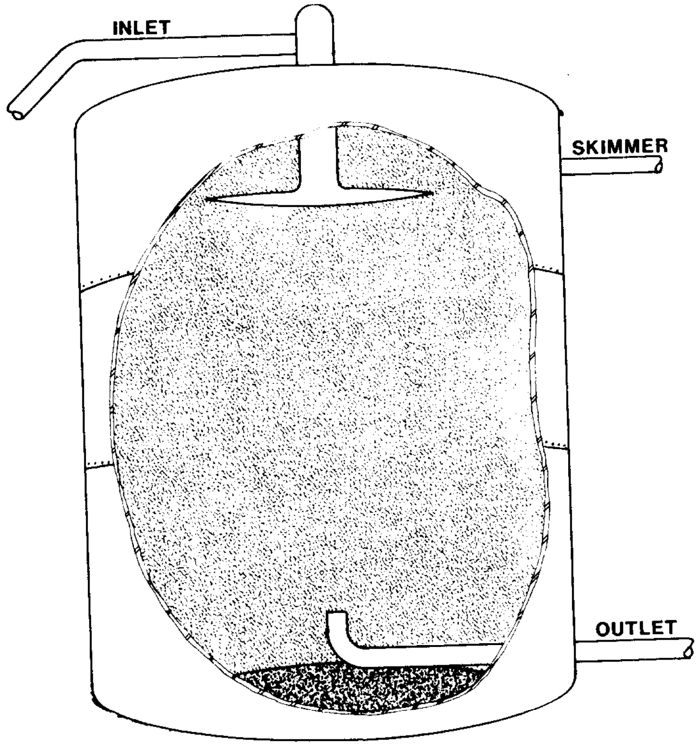

FIGURE 5

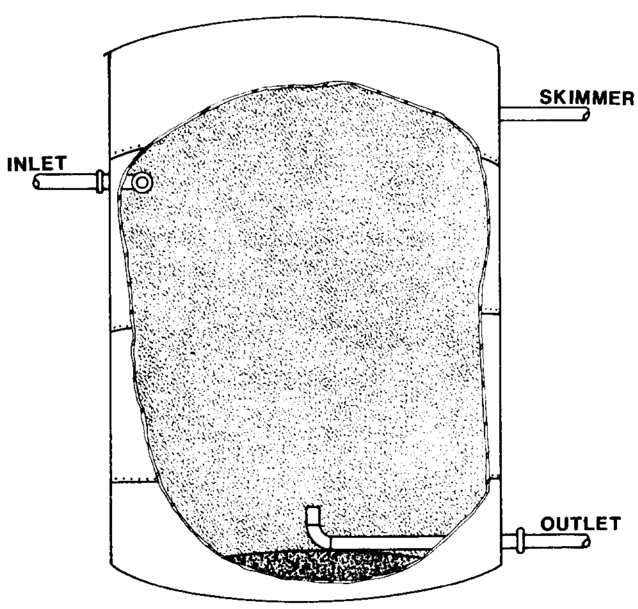

FIGURE 6