WASH TANK DESIGN AND APPLICATION FOR EMULSION TREATING

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INTRODUCTION

The use of wash tanks for emulsion treating has been employed in the oil field for many years, even though direct fired vessels have been the most popular treating device in recent times. With the present concern for energy conservation, and with the ever-increasing value of residue gas, cold treating of emulsion with a wash tank may be the most attractive method in many applications.

Regular production stock tanks have been adequately utilized as wash tanks in "stripper" operations where the quantity of emulsion and producing GOR is small. In these simplified installations, the produced fluid is piped directly to the tank, and oil is spilled through an equalizing line to another stock tank. A water leg may be used to control the water wash level or, if water production is minimal, the water may be simply contained in the tank and trucked as necessary. This type installation may suffice in marginal operations; however, where larger volumes of emulsion are to be handled, significantly more design and installation work is necessary to provide an efficient treating device at the least possible installation cost.

PRINCIPLES OF OPERATION

Water Wash

The volume of water used to wash the emulsion aids treatment by coalescence. The water droplets in the emulsion are contacted by the water wash to form larger droplets which allows them to settle out of the oil phase faster. A chemical demulsifier will increase the effectiveness of the water wash by breaking down the emulsion film and allowing the water droplets to more readily collide with one another and contact the water wash. Agitation also plays an important part in thoroughly mixing the demulsifier with the emulsion and by enhancing the chances of coalescence while the emulsion passes through the water wash.

The quantity of water wash used in a wash tank will generally be from 25% to greater than 50% of the tank's capacity. A generous volume should be allowed to assure good coalescence, but applying good agitation to the emulsion is more beneficial than an excessive volume of wash water.

Settling Time

The time in which the emulsion is retained in a wash tank to allow complete water-oil separation is probably the most important aspect of good treating. Settling time will typically run from 4-24 hours; however, emulsion conditions can vary greatly from field to field, even in similar formations. Due to this, the proper settling time for a given application should be determined through careful testing, if possible.

Emulsion samples are normally collected at the wellhead for bottle testing. A well that has the worst emulsion should be selected and the samples should be chilled to the coldest expected producing temperature. These tests are normally conducted by a chemical company as a chemical demulsifier is usually necessary to aid emulsion treating. Several things can be determined by the tests.

1. The chemical company's most effective demulsifying compound can be selected.
2. The concentration of demulsifier and the settling time required can be determined.
3. The minimum temperature at which the

emulsion can be effectively treated can be determined.

4. The demulsifier cost per barrel of treated oil can be estimated.

The role of the demulsifier in the settling section of a wash tank is to reduce the interfacial tension between the water droplet and the emulsifier. This allows the droplet to settle freely from the oil.

EXTERNAL DESIGN

Inlet Flume

The inlet flume (Fig. 1) consists of a large-diameter pipe extending to the top of the tank with a larger-diameter gas section on top extending above the tank deck. The inlet emulsion line enters the gas section about midway. The sole purpose of the flume is for gas separation before the emulsion enters the wash tank. Normally, no internal parts are used inside the gas section; however, if more complete separation is necessary, an impact angle or centrifugal ring can be inserted.

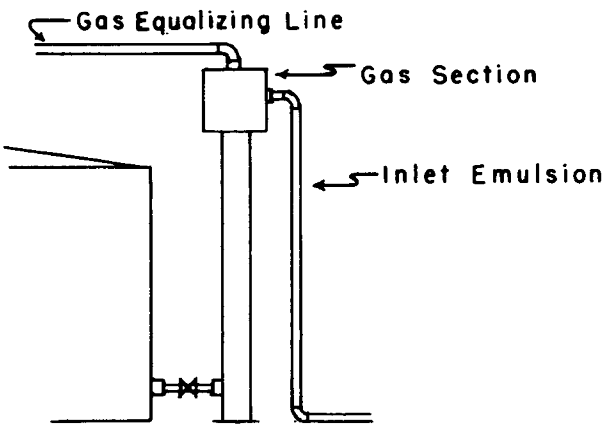

FIG. 1 – INLET FLUME

The inlet flume can also be mounted inside the tank (Fig. 2) with the gas section resting on the deck. The downcomer protrudes to near the bottom of the tank with a circular spreader installed at the bottom of the pipe. This type can be troublesome if corrosion occurs in the downcomer and the raw emulsion goes directly to the settling section.

Water Leg

The type of water leg (Fig. 3) chosen for a wash tank differs in no way from a heater-treater water leg. One with a fixed spill point is the most trouble-

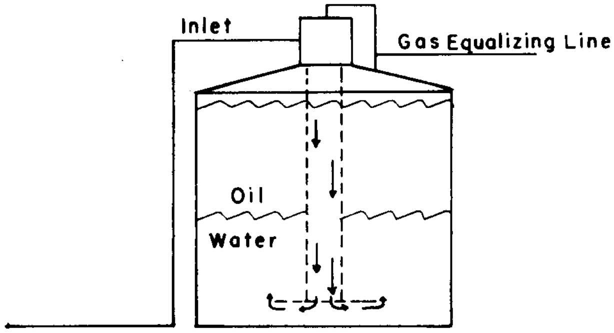

FIG. 2 – INTERNAL FLUME

free; however, an adjustable type may be desirable to raise the level of the water-oil interface in the warmer months of the year. This will reduce the oil retention time; thus, if the extra time is not needed, weathering of the oil can be reduced. The adjustable types often prove troublesome when scale or solids deposition lock the adjustable mechanism in place.

The desired water-oil interface level can be accurately set by properly determining the water leg spill point. A representative number for the oil gravity and produced water specific gravity is needed to accurately calculate the spill point (see Appendix).

INTERNAL DESIGN

Emulsion treating in the water wash, as previously mentioned, requires some agitation to assure coalescence. More specifically, any change in direction or velocity of the inlet emulsion will tend to separate the water droplets from the emulsifier. This is achieved in a heater treater by using a downcomer baffle or knockout compartment in the bottom of the water section, and a series of baffles to divert the fluid as it travels upward. A wash tank should contain similar equipment to divert, and thus agitate, the emulsion while it is in the water wash

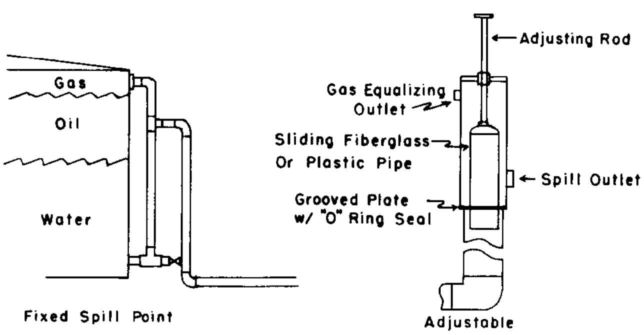

FIG. 3 WATER LEG

section of the tank. Agitation is not needed, nor desired, after the emulsion enters the oil section and begins to settle; however, there must be fluid movement throughout the settling section to achieve the full benefit of the settling section's volume. It has been proven by laboratory models that if there is a direct route from the emulsion inlet to the oil outlet, the oil will channel through the settling section leaving dead areas in the tank which do not contribute to retention time. These dead areas, which deduct from retention time, have misled many to believe that wash tanks would not work since they used the entire settling section in calculating retention time.

Inlet Spreader

The inlet spreader's purpose is to initiate good agitation as the emulsion is discharged from the flume into the water wash. A typical design is shown in Fig. 4. This type is shown with a serrated edge around the skirt. The spreader is normally circular in shape with a diameter 20-25% as large as the tank diameter. Rather than having a serrated edge on the skirt, the spreader could be perforated on the skirt or on top to allow the emulsion to percolate through the holes.

The internally mounted flume, as shown in Fig. 2, can have a similar-type spreader with a skirt around the edge.

Baffles

A vertical baffle plate can be inserted between the emulsion inlet and oil outlet to prevent direct channeling in the tank's settling section. Figure 5 shows the baffle position with respect to the inlet and outlet connections to force the oil to completely revolve around the tank before it can exit.

The solid baffle plate will create fluid movement in most of the tank's volume, but dead area may still exist, expecially in a large-diameter tank. Additional baffles can be installed to more effectively move all the fluid. Figure 6 shows an

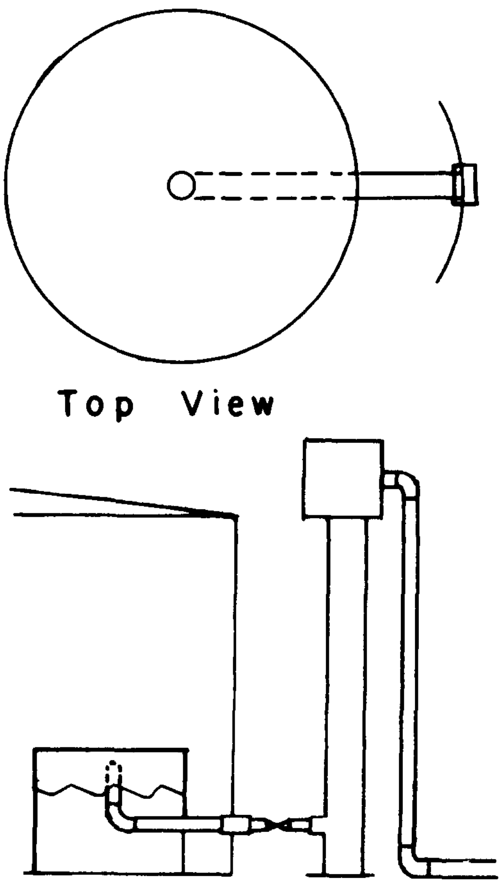

FIG 4 — INLET SPREADER

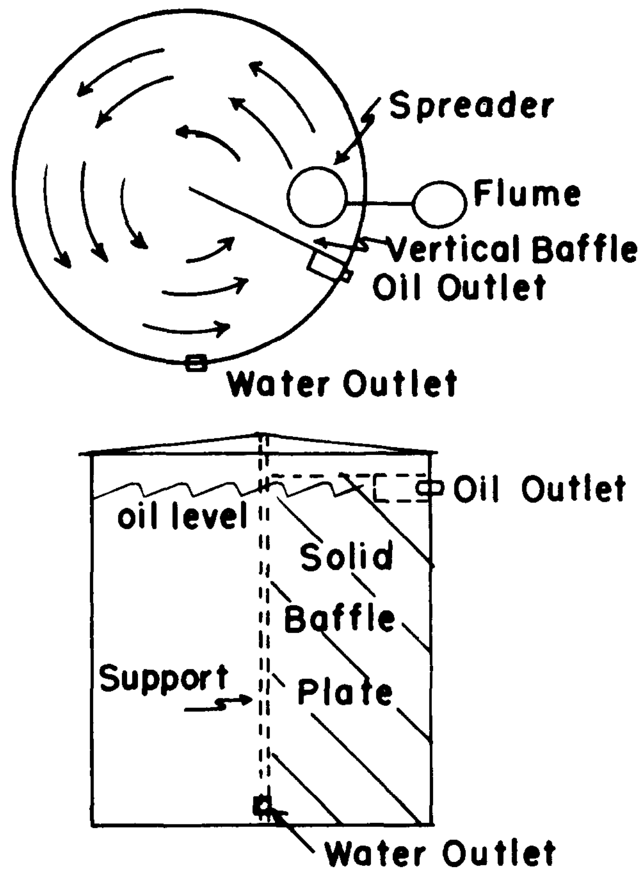

FIG. 5 — INTERNAL BAFFLE

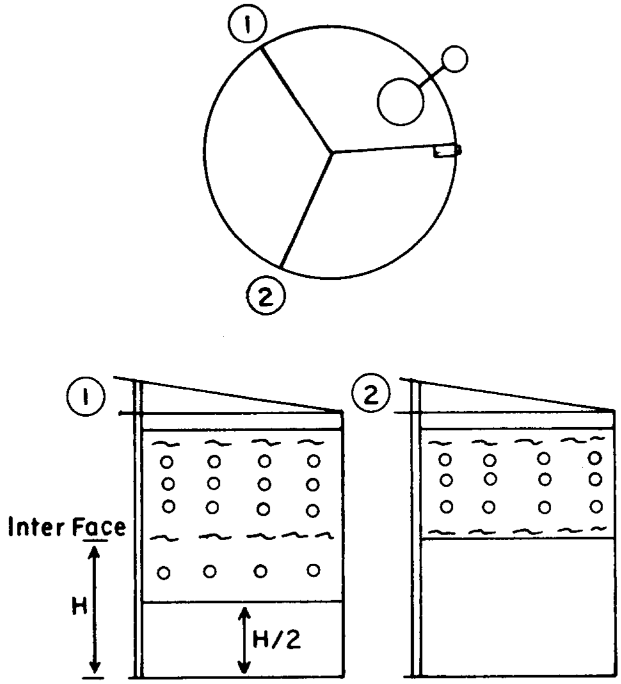

FIG. 6 — INTERNAL BAFFLES

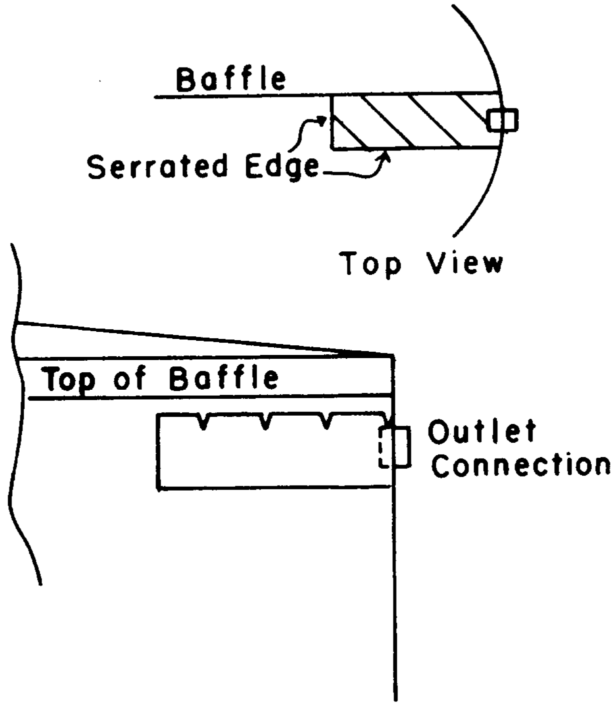

FIG. 7 — SKIMMER TROUGH

arrangement of two additional baffles positioned 120 degrees apart. These baffles do not extend to the tank bottom and are perforated with smaller or fewer holes toward the middle of the tank to make the fluid flow equally as it travels in a circumferential path around to the outlet.

The perforations should be closely spaced both horizontally and vertically so that the circumferential movement is not restricted and additional dead space is not created.

Outlet Skimmer Trough

The skimmer trough consists of an open-top box surrounding the outlet connection welded to the tank shell or to the shell and baffle plate. The top edge of the trough can be flat or serrated. This device will allow the outlet oil to be skimmed from the very top of the settling section, further allowing full benefit of the settling section's volume.

GENERAL DESIGN CRITERIA

The advantages or disadvantages of a particular type tank hold true for production tanks, water tanks, and wash tanks, as well. The initial installation cost is less for a bolted tank; but leaking gaskets have to be contended with, and internal protective coatings are more difficult to adequately apply. If a welded tank is constructed, it should be according to the same specifications as for production tanks; API Standard 12D or 12F. The type bottom selected (flat, coned with sump, etc.), as in other tanks, should be based on the solids settlement expected.

The connections, regardless of type, should be ample in both the number installed and in size. The most important, as to their size, are the emulsion inlet, oil outlet, water outlet, and gas vent. In addition, one or more connections should be installed at the height of the oil-water interface level so the interface can be worked if paraffin or iron buildup occurs.

A major design consideration, after the required size of the wash tank has been determined, is the height of the tank. This is dependent upon the height of the production and water-handling tanks. After selecting an adequate height, the differential height between the oil and water spills and the respective tanks can be used to size the spill lines. Anticipated scale and paraffin problems should be allowed for in sizing these lines.

Corrosion Protection

An internal protective coating is essential on the water-wetted surfaces in the wash tank where the produced water is corrosive, which is the case in a majority of the fields. The tank and all internal equipment should be coated from the bottom to a level above the water-oil interface. In fields where gas corrosion is expected, the wash tank should be coated on the internal deck and on the shell down to below the oil level. The inlet flume is also subjected to corrosion and should be coated. An acceptable coal tar epoxy or higher quality coating should be used and applied in accordance with NACE's approved standards.

Corrosion in wash tanks occasionally occurs in the form of a galvanic cell. This type of corrosion can occur only in water-wetted portions of the tank, as the water provides the electrolyte. Any small potential difference between metals in the tank completes the galvanic cell, and corrosion will commence on the anodic metal. If internal epoxy coating does not supply enough resistance to break the galvanic cell, the installation of a cathodic protection system may be a worthwhile investment. Cathodic protection should be applied by hanging the sacrificial or impressed current anode in the water wash section, suspended from the deck by an insulated conductor wire. The typical current density required for protection is 10 milliamperes per square foot of wetted steel surface.

SPECIAL PROBLEMS

One of the most prominent problems with wash tank operations is in the water-oil interface. The interface typically will consist of such materials as water, oil, paraffin, sand or clay particles, and iron sulfide. The interface will not hinder the wash tank's efficiency if it is only a few inches thick and the paraffin and solids do not become extremely hard. In fact, a moderate interface can serve to some degree as a filtering medium and can actually benefit the treating process. The problem occurs when the interface continues to grow and becomes harder. Where interface buildup occurs, chemicals can be used to help control the problem; surfactants to water-wet the solids and allow them to settle to the tank's bottom, and paraffin solvent or dispersant to suspend the paraffin in the oil. Hot-oiling the interface by pumping into the tank at the interface level or drawing off the interface and circulating back through the treating facilities may be helpful but normally not too effective, due to the area the interface covers. If the interface becomes too thick, physical removal may be necessary by draining and entering the tank. These extreme steps can usually be prevented by monitoring the interface buildup periodically and treating the problem chemically.

Paraffin in the oil spill line or scale in the water leg and spill line can both cause problems and need to be inspected and removed as necessary. Scale inhibitor or paraffin solvent can be used if the buildup of either is too rapid.

In the event that bad oil is encountered, the rate at which the LACT divert or the circulating pump returns to the wash tank inlet is critical, as it is in any treating facility. The circulating rate should be maintained at a bare minimum to prevent overloading the treating facility and further worsening the situation.

Sand problems are rare in the Permian Basin area; however, in areas where unconsolidated sand formations are found, equipment is installed in wash tanks to remove sand as it settles to the bottom of the tank. Sand pans with draw-off lines are spaced over the tank's bottom and the draw-off lines are routinely opened and purged to remove the sand by means of water velocity.

CONCLUSIONS

Wash tank operation has certain advantages over the direct fired heater treater which makes it the best emulsion treating facility for some applications. The following lists a few of the pros and cons of wash tanks versus heater treaters.

Advantages

1. Eliminates residue gas usage; the wash tank uses coalescence and retention time in place of applied heat.
2. No working parts. Heater treaters require maintenance on dump valves, a back-pressure valve, emergency relief valve, fuel gas regulators, and thermostatic controls. Fire tubes also pose occasional problems.
3. Safety. Heater treater fires have been common occurrences in past years; and even with the widespread use of flame arresters today, the direct heating of a flammable substance is still a fire hazard to some degree.

4. Less gas driven off. Applying intensive heat to the oil will drive off gas, thus reducing the volume of oil to be shipped. Price penalties due to a lower oil gravity can also be suffered.

Disadvantages

1. Gas-handling capacity. Wash tanks are not designed to handle large gas volumes, although if the producing GOR is excessive, neither are heater treaters.
2. Internal coatings. Where internal coatings are used, the time and expense of inspecting and maintaining the protective coating is significant.
3. Chemical usage. All emulsions react differently with respect to retention time or heat, but the chemical demulsifier required will normally be greater in wash tank operation.

An economic comparison is, of course, the key factor in selecting the most feasible treating system. The best background information attainable, experience, accurate bottle testing, or other parameters, should be used to determine the optimum system.

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APPENDIX

Example: Determine the height to the water leg spill point on a wash tank with the given conditions:

Oil Gravity	=	36° API
Water Specific Gravity	=	1.05
Height to Oil Spill	=	23 ft
Height to Interface Level	=	10 ft
Height to Water Outlet	=	1.0 ft

$H_o = 23 \text{ ft} - 10 \text{ ft} = 13 \text{ ft}$

$H_w = 10 \text{ ft} - 1.0 \text{ ft} = 9 \text{ ft}$

$$\text{Oil Specific Gravity} = \frac{141.5}{131.5 + 36} = 0.845$$

1.00 Specific Gravity = 0.433 psi/ft gradient

Oil Gradient = 0.433 × 0.845 = 0.366 psi/ft

Water Gradient= 0.433 × 1.05 = 0.455 psi/ft

Water Leg Spill Point
Fig. 1A

Hydrostatic pressure inside tank = hydrostatic pressure in water leg.

$$13 \text{ ft} \times 0.366 \text{ psi/ft} + 9 \text{ ft} \times 0.455 \text{ psi/ft} = H \times 0.455 \text{ psi/ft}$$

$$H = \frac{13 \times 0.366 + 9 \times 0.455}{0.455}$$

$$= \frac{4.76 + 4.10}{0.455}$$

$$= \underline{19.5 \text{ ft}}$$

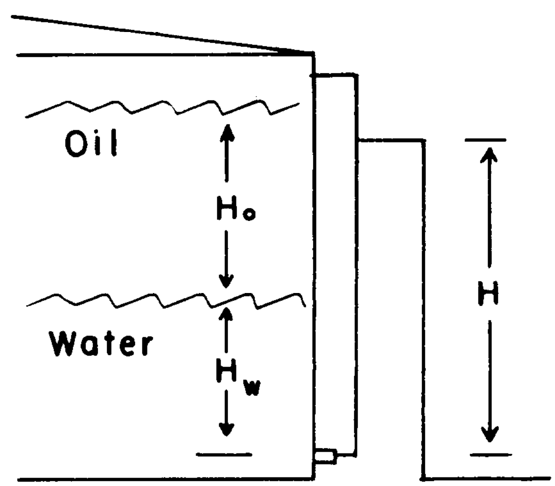

FIG. 1-A — WATER LEG SPILL POINT