Treaters Will Work

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ANALYSIS OF THE PROBLEM

A close examination of a wellstream under a microscope would show oil, water droplets, and solids such as sand, undissolved salts, or metallic oxides. Not all these appear in every wellstream, however, water droplets are almost always present.

Crude oil emulsions consist of these fine water droplets dispersed in the oil.

Most wellstreams contain water droplets of varying size. If they come together and settle to the bottom of a quiet sample within five minutes, they are called "free water". This is an arbitrary definition but is generally used in designing low pressure equipment to remove water that will settle out rapidly.

If left standing, water will continue to settle to the bottom of the sample, and if enough time is allowed, all of it may settle out of the oil. In many cases, time is an important and costly item to provide so it becomes necessary to devise a means of speeding up the settling process.

Frequently the water droplets remaining after the free water has settled out are too small to settle out without some sort of treatment. This type of emulsion is called a very stable or "tight" emulsion. If the water droplets vary in size considerably and most of them are relatively large, the emulsion is called an unstable or "loose" emulsion.

For practical purposes, all water remaining in the crude after the free water settles out is considered to be in an "emulsified state" and is to be removed by treating equipment.

What is Treating?

Treating is simply a procedure that has been devised to separate crude oil from the water and foreign material produced from the reservoir. In treating a wellstream, the treater "breaks" the emulsion and separates the oil from the water, sand, and other sediment produced with it.

How Does an Emulsion Form?

When water and oil are produced together from a formation, the stream always contains sand, carbon, carbonates, sulfates and many other organic and inorganic materials. These foreign materials become more important as the fluids churn their way "up the hole" because the action of the tubing restrictions, well choke, gas lift valve, or pump agitates and blends the oil, water, and foreign material together. The greater the agitation, the more finely divided the water droplets become. The foreign materials, partially soluble in the fluids and sometimes suspended in the stream, act as an emulsifying agent by increasing the strength of the film surrounding the water droplets. No emulsion would be stable without the presence of this emulsifying agent.

Two things, therefore, are necessary to produce a stable emulsion of oil and water - agitation, and an emulsifying agent.

What Are the Important Physical Characteristics of an Emulsion?

Drop size. The drop size is a very important aspect of the treating problem for three reasons:

First, smaller droplets take longer to settle out. Consider two drops, for instance - the diameter of one being half that of the other. The smaller droplet weighs one-eighth as much as the larger, but has one-fourth the surface area. This means that it has only one-eighth the gravitational attraction of the larger one, yet its frictional resistance to falling is one-fourth that of the larger one. Under equal conditions, therefore, it would take much longer for the smaller droplets to settle out.

Second, smaller droplets have much stronger films around them, making them harder to rupture upon impact with other droplets.

Third, the uniformity of drop sizes is important. If larger droplets are available upon which smaller ones can build, they will grow to proportions sufficient for separation much quicker than if the droplets are of uniform size.

Each lease in a given field may present slightly different problems. The per cent of water produced, the lifting methods, and less definite factors all tend to produce differences in drop size from lease to lease or well to well. These may in turn be reflected in different treating costs and treater capacities - often within a single field.

Film strength. As pointed out previously, the presence of some foreign materials in an emulsion increases the strength of the film surrounding a drop of water. Also, smaller droplets are much harder to rupture than larger ones. Film strength of a drop of water will therefore vary not only with drop size, but also with the composition of the impurities. To break the film, it is necessary to introduce chemical action and heat to weaken it. Water droplets can then merge upon contact and form larger droplets with sufficient mass to settle out of the oil rapidly.

Percentage of water. The amount or percentage of water produced with the crude will also greatly affect the treating problem. A large percentage of water tends to decrease the dispersion, causes a great variation in drop size, and increases the possibility and rate of contact between water droplets. These factors promote more rapid settling.

Differential density. Another factor that affects the settling time required is the relative density of the oil and water. For instance, oil being produced may be as light as 45 pounds per cubic foot or as heavy as 62.4 pounds per cubic foot. Water may vary from 62.4 pounds per cubic foot (fresh water) to 80 pounds per cubic foot (salt water). One extreme example is the 17 degree API gravity oil and fresh water produced in Wyoming. This system has a differential density of only three pounds per cubic foot. At the other extreme is the 40 deg. API gravity oil and salt water (79.5 pounds per cubic foot) produced in Michigan. This system has a differential density of 28 pounds per cubic foot. Given equal drop size, equal film strength, and equal viscosity (by heat, of course), the Michigan emulsion would treat out in less than one-ninth the time required by the Wyoming crude.

Viscosity. The oil viscosity is another important factor in treating oil. Since viscosity is a measure of the fluid's resistance to flow or friction, it is also an indication of how easily water may settle out. A high viscosity indicates slow settling, whereas low viscosity indicates rapid settling.

Generally, low gravity crude has a high oil viscosity and high gravity crude a low viscosity. Two different oils of the same density, however, may vary greatly in viscosity. For instance, the crude of Talco and Seven Sisters Fields in Texas is 22 deg. API. The Talco crude, however, has a viscosity of 340 SSU whereas the Seven Sisters Field crude has a viscosity of 69 SSU. Other things being equal, the Talco crude would "drag" or hold up the drops of water much longer than the crude of the Seven Sisters Field.

There are many other factors affecting the treating problem such as weather conditions, production methods, etc. All could be discussed at great length but without much definition as to final effect on the treating problem.

The foregoing discussion illustrates why treating oil is an art. At the same time it explains some of the factors that must be considered along with a generous amount of field experience and field history to assure satisfactory treating operations.

STEPS IN TREATING

Now that the problem has been analyzed, the next step is how to break the emulsion and separate the water from the crude. There are essentally five steps in the proper treating of crude oil emulsions.

1. Chemical injection
   The purpose of chemical injection is to introduce a chemical into the wellstream that will neutralize the foreign material acting as an emulsifying agent and thereby weaken the film surrounding the water droplets. To neutralize an agent that produces a water-in-oil emulsion, an agent may be introduced that favors an oil-in-water type of emulsion. The neutralizing agent is added in only such amount that it will cause a breakdown of the emulsion and allow separation.

   To get the most out of chemical injection, the actual location of the injection point is important. It should be located at a point far enough upstream from other treating equipment to allow adequate mixing. A good point is at the wellhead or the location of some other restriction such as a choke or header. Here there is sufficient turbulence and mixing and provision for sufficient time for the chemical to exert its influence on the emulsion before entering any other equipment.

   Unfortunately, not all treating problems can be solved by simply injecting a chemical into the wellstream.
2. Separation of Gas and Free Water
   During the time the wellstream travels from the reservoir to the treating equipment, some gas and free water separates from the crude oil. This is especially true of loose emulsions and also some tight emulsions that have been treated with chemicals.

   It is advantageous to separate the gas and free water from the crude oil emulsion before proceeding with any further treating because (1) Removal of the gas reduces turbulence and agitation in the free water knockout and settling sections. This allows quiet separation of the free water from the crude oil emulsion. (2) Removal of free water eliminates unnecessary heating of water that has already broken out of the emulsion. This reduces the heat load on the heating equipment and cuts treating costs.
3. Application of Heat
   Heat produces three effects upon crude oil emulsions:
   a. Heat increases the effectiveness of the chemical on the emulsion.
   b. Heat reduces the viscosity of the oil and oil-water emulsion, weakening the film and making it easier for the water droplets to settle out.
   c. The energy transferred to the emulsion as manifested by the increase in temperature, increases the movement of the water droplets and affords more collissions between droplets per unit of time.
4. Filtering
   Heat alone will not reduce all emulsions to pipeline quality oil. It is often necessary to provide some filtering medium which offers a large surface on which water droplets can collect and merge into sufficient mass to break away and settle out. The filter is used to coalesce the last, hard-to-get trace of water from the oil.

   Excelsior has proved to be the best filter medium. Many others have been tried over a period of several years but excelsior has proved to be the most efficient. Fortunately, it is also economical.
5. Settling
   In treating, adequate time must also be provided for settling. This should be carried out in an area having as little agitation as possible. If this can be done at or near the treating temperature, the additional advantage of reduced viscosity and added chemical effect can be utilized.

   These five steps in treating may be shifted in their order of application. It has been found through years of experience, however, that the order in which they have been discussed produces the best results. Filtering and settling are frequently carried out in the same area and concurrently. They have been separated here for purposes of discussion.

Other Auxiliary Aids

One of the bases on which pipeline companies purchase oil is its gravity. The application of heat to a crude oil will cause some of the lighter fractions in the oil to "boil off". This reduces the gravity and volume of the oil that a producer sells. A rule of thumb common in the oilfield is that a reduction in gravity of one degree API means a reduction in saleable volume by 2.5 per cent.

If the crude oil emulsion is maintained under pressure during the treating process, more of these lighter fractions can be retained in the treated oil and its gravity sustained. As a further aid to conservation, the cool gas from separation may be mixed with the gas produced by heating, causing some of these fractions to condense and fall back into the treated oil.

An external heat exchanger may also be added to the system as an auxiliary aid. This unit is a shell and tube type heat exchanger. The usual arrangement is for the emulsion to flow through tubes immersed in the hot oil. In this manner the treated oil is cooled somewhat and stock tank losses are reduced. The heat that the wellstream production picks up reduces the heat load on the firebox.

RULES FOR OPERATION

The first rule for operation of equipment is proper location or arrangement of equipment. Units containing fireboxes should be located far enough away from a tank battery to prevent escaping gas from collecting around the firebox.

Quite often on damp, cold mornings escaping gas will hug the ground and collect in low spots. These areas should be avoided when locating treaters or heaters.

It is good practice to pipe the outlets from relief valves and SAFETY HEADS away from the treater. The same consideration should also be given to stock tank vent lines. This eliminates any chance for gas, that might be discharged from these pressures relieving devices, to come in contact with the firebox.

Tank vent lines should also be installed in such a manner as to drain and be free of water at all times. A low spot in a relief line could accumulate water which in cold weather would freeze and interfere with the operation of safety relieving devices. It is suggested that these lines be piped to a pit in such a way that they will drain toward it and be free of liquid at all times. Pressure treaters should be located on high ground with respect to the stock tanks so that oil will flow by gravity to the tanks whenever possible.

Essentially, there are two general types of treaters on the market today - vertical and horizontal. The same operating practices should be followed for both types. With the horizontal treater, it is definitely necessary to pipe the relief valve and SAFETY HEAD discharge away from the treater. The SAFETY HEAD and relief valve on this type of treater are located below the top of the stock tanks. If the treater were over-pressured, the rupturing of the SAFETY HEAD disc or popping of the relief valve would result in a loss of gas pressure, and oil would flow through these devices instead of going to the stock tanks.

When fuel gas is taken from the treater or from a separator, a drip should be installed in the fuel gas line. It should have an automatic shut-off feature that would shut off the fuel gas supply to the burner if the fuel line ever became filled with oil or condensate. The use of a drip insures a dry gas supply to the burner and pilot light, and this one feature alone eliminates a majority of pilot light troubles.

A second rule for operation is to know your equipment and how it works.

There are two methods of controlling the oil-water interface on treaters, a water siphon or an interface float.

How a Water Siphon works

Figure 1 shows a schematic drawing of a BS&B Water Discharge System. The arrows show the path of the water as it leaves the treater. The water passes through the piping and up to the top of the adjustable pipe. The height of the oil-water interface may be adjusted by changing the height of this pipe. The correct operation of a siphon depends on a fixed oil elevation in the treater. This is usually accomplished by a spill-over weir on the oil outlet. By means of equalizing piping, the pressure in the siphon is maintained the same as that in the treater. Therefore, any flow of fluid from the treater to the siphon depends only on the levels maintained in the treater. In principle, the height of the water column in the adjustable pipe (A) will be such that its weight per unit area would equal the combined weights per unit area on the oil and water in the treater. Since water is heavier than oil, it takes a shorter column of water to counterbalance a combined column of water (B) and oil (C). Raising the adjustable pipe will cause the oil-water interface to rise. Lowering the pipe will cause the interface to lower. When the water spills over the top of the adjustable pipe, it falls down into the larger chamber surrounding the adjustable pipe and is discharged by the water dump valve.

How an Interface Float works

An interface float (1) is sometimes used to control the oil-water interface on treaters. It is a large float mounted through a manway on the vessel at the elevation at which the interface is to be controlled.

In order for the float to work it must ride on the interface between the oil and water. In order to do this, the float must be heavy enough to sink in oil and light enough to float on water. It has been pointed out that oil is from 3 lb to 28 lb per cubic foot lighter than water, therefore the float must weigh approximately half way between the densities of the water and oil on a given application.

In order to keep the weight of the float from becoming excessive and because it must weigh different amounts on each application, the float is made from lighter material and is then loaded internally with liquid until it reaches the correct overall density for the specific application. The loading is done by filling the float with liquid and weighing it until the correct density is reached before installing through the manway or as in the preceding illustration it is loaded after installation by forcing liquid in through the flexible hoses (3) until the desired weight is obtained. The oil water interface is manually controlled at the center of the float manway and liquid is put into the float until it sinks to a horizontal position. It is then connected by mechanical linkage to a water valve. The interface float is independent of a fixed oil level in the treater. The most common method of dumping water and oil from a treater which is siphon operated is with a head operated discharge valve.

How a BS&B OWC Valve works

It will be noted in Figure 3 that the top of the OWC valve diaphragm is connected with the treater pressure to equalize the same pressure acting on the bottom of the diaphragm through the siphon. On the bottom side of the diaphragm the effective force attempting to push the valve plug out of the seat is the weight of water in the piping. To counterbalance this force, a weight and lever is directly attached to the top of the diaphragm. When the height of water in the siphon chamber increases such that the weight of water pushing against the diaphragm is greater than the force exerted by the weight and lever the valve will open and water will be discharged until these forces again balance each other. The height to which the water will build up in the piping can be adjusted by changing the weight position on the lever. This valve will work equally well on oil or water discharge lines from treaters and is used for this purpose with treaters when a water siphon is used. These valves are equipped with small drip pots on the equalizer piping so that a supply of dry gas is assured on the top side of the diaphragm.

When operating a treater it should be remembered that it is a compact unit which has replaced several pieces of equipment that were used to treat oil a few years ago. Due to this compactness, treaters are much more susceptible to overloading, slugging and fouling due to sludge accumulation, etc. It is therefore important to give the treater the best possible chance to work and to make periodic inspections and, if necessary, cleanings to insure that the treater operates properly.

When putting a treater into operation several things need to be taken into consideration and done.

The first consideration should probably be the firebox. Never fire a firebox until it is completely covered with fluid, preferably water. The treater should be filled with water above the firebox. This is not always necessary if there is sufficient produced water to cover the firebox in 1 to 2 days. If the firebox is fired against oil or emulsion the fire should be kept low so as to minimize hot spots and stresses due to firing to oil.

Before firing the firebox, the pilot light should be thoroughly cleaned and inspected. A stable pilot is absolutely essential to trouble-free operation of treaters. The pilot should be located so as to light the gas from the burner as it comes out of the burner nozzle. This is usually about 1-in in front or ahead of the burner nozzle. Pilots should be cleaned periodically. Drip pots on the gas line and pilot should be drained every day to keep liquid out of the fuel system.

Firebox Inspection

Periodic firebox inspection is required for the efficient and safe operation of a treating system. A deposit of sediment or scale on the outside of a firebox reduces the heating capacity and causes the skin temperature of the metal to exceed safe limits. Higher skin temperature results in more rapid deposition of salts, a serious weakening of the firebox, high concentrations of stresses at critical points, and a more rapid rate of metal oxidation. Should a firebox crack, cave in, or burn out during the time it was firing, a serious fire may result. Therefore, a definite schedule for firebox inspection and cleaning is important.

The frequency of firebox inspection is almost impossible to determine in advance. Much depends upon the nature of the sediment in the wellstream, quantity and type of dissolved salts in the water, and corrosiveness of the crude in each locality. It is a good idea to draw upon the experience of other operators in the field when setting up an inspection schedule. A periodic visual examination and slight tap of a hammer can tell much about the condition of a firebox. This, along with periodic cleaning will provide efficient and safe operation throughout its life.

Firebox inspection should also include the inside of the firebox. A collection of soot and scale inside the firebox not only reduces the amount of heat transferred to the heating

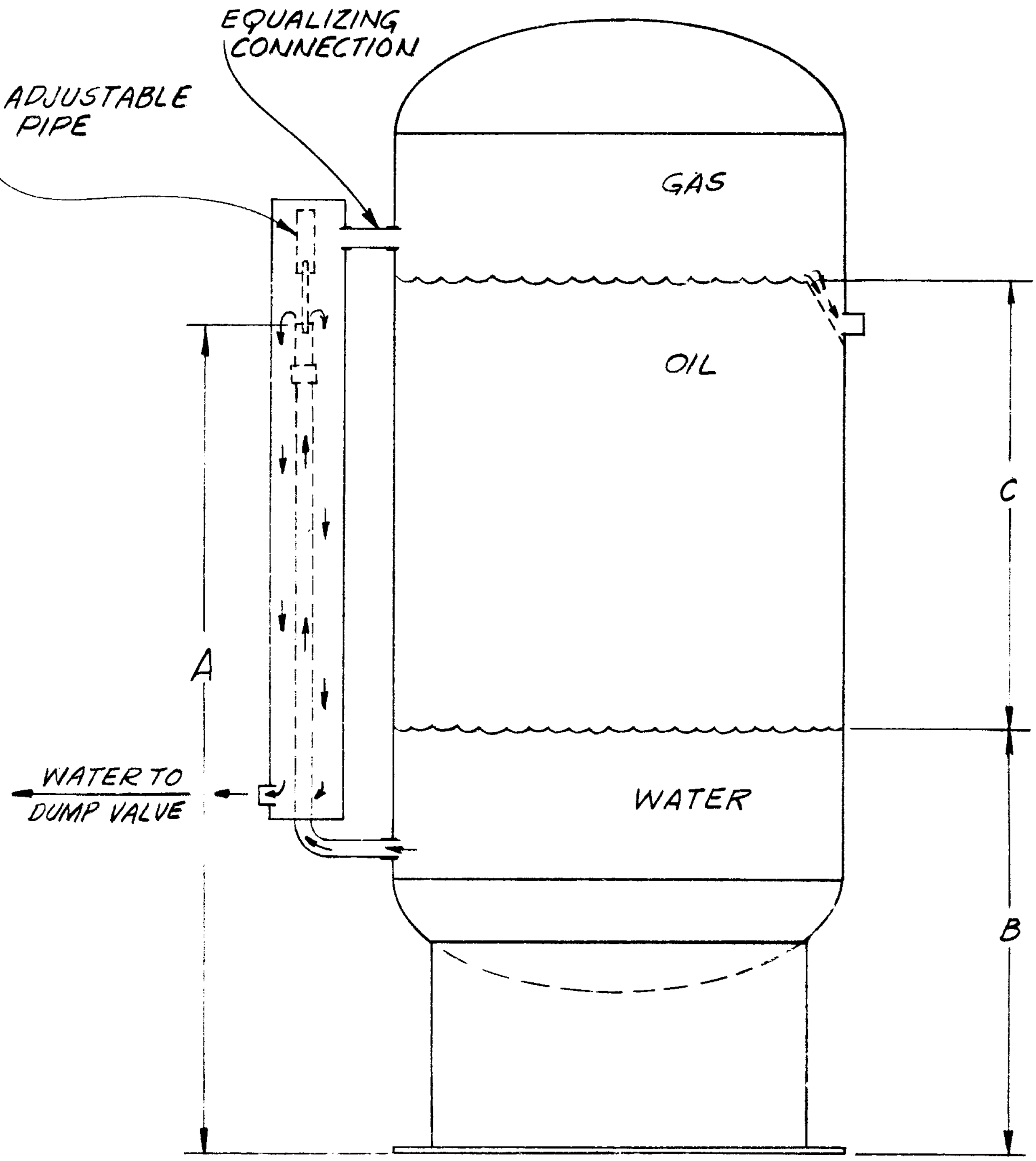
EQUALIZING CONNECTION
ADJUSTABLE PIPE
GAS
OIL
WATER
C
A
B
WATER TO DUMP VALVE

Figure 1

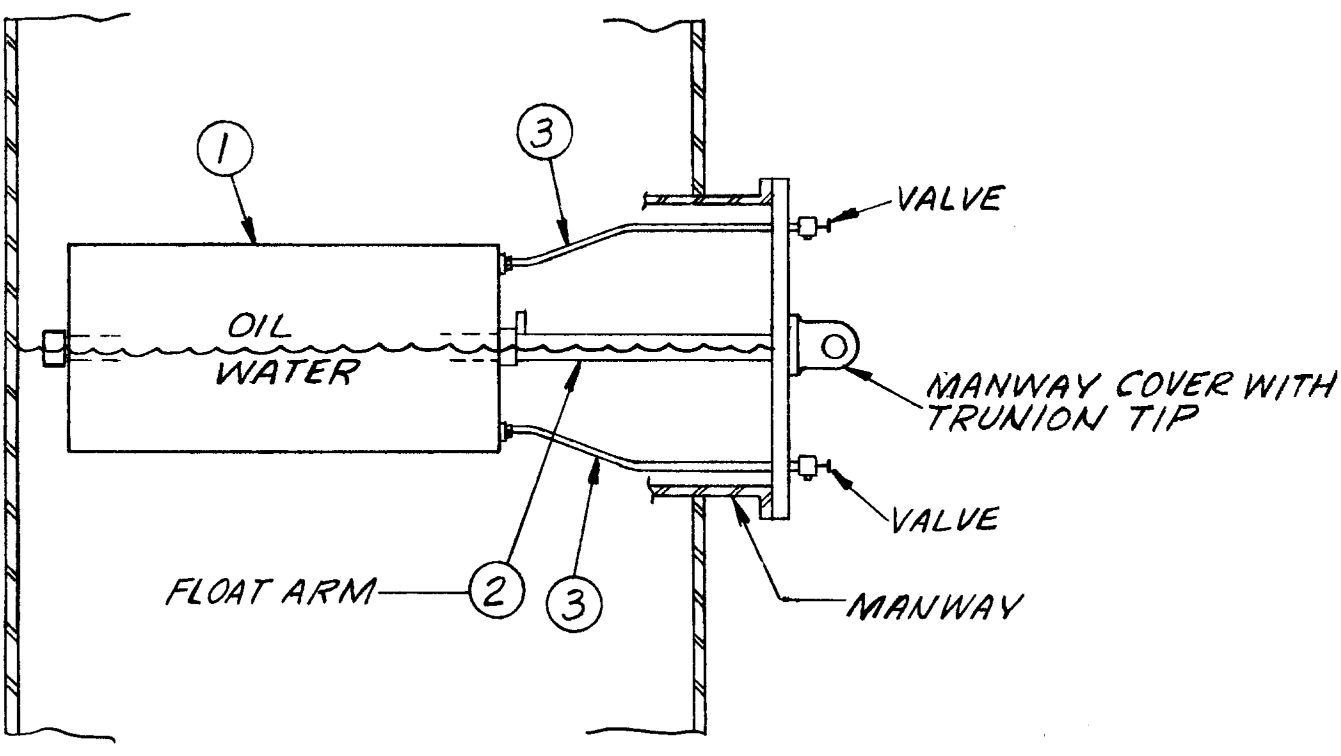
1
3
VALVE
OIL
WATER
MANWAY COVER WITH
TRUNION TIP
VALVE
FLOAT ARM
2
3
MANWAY

Figure 2

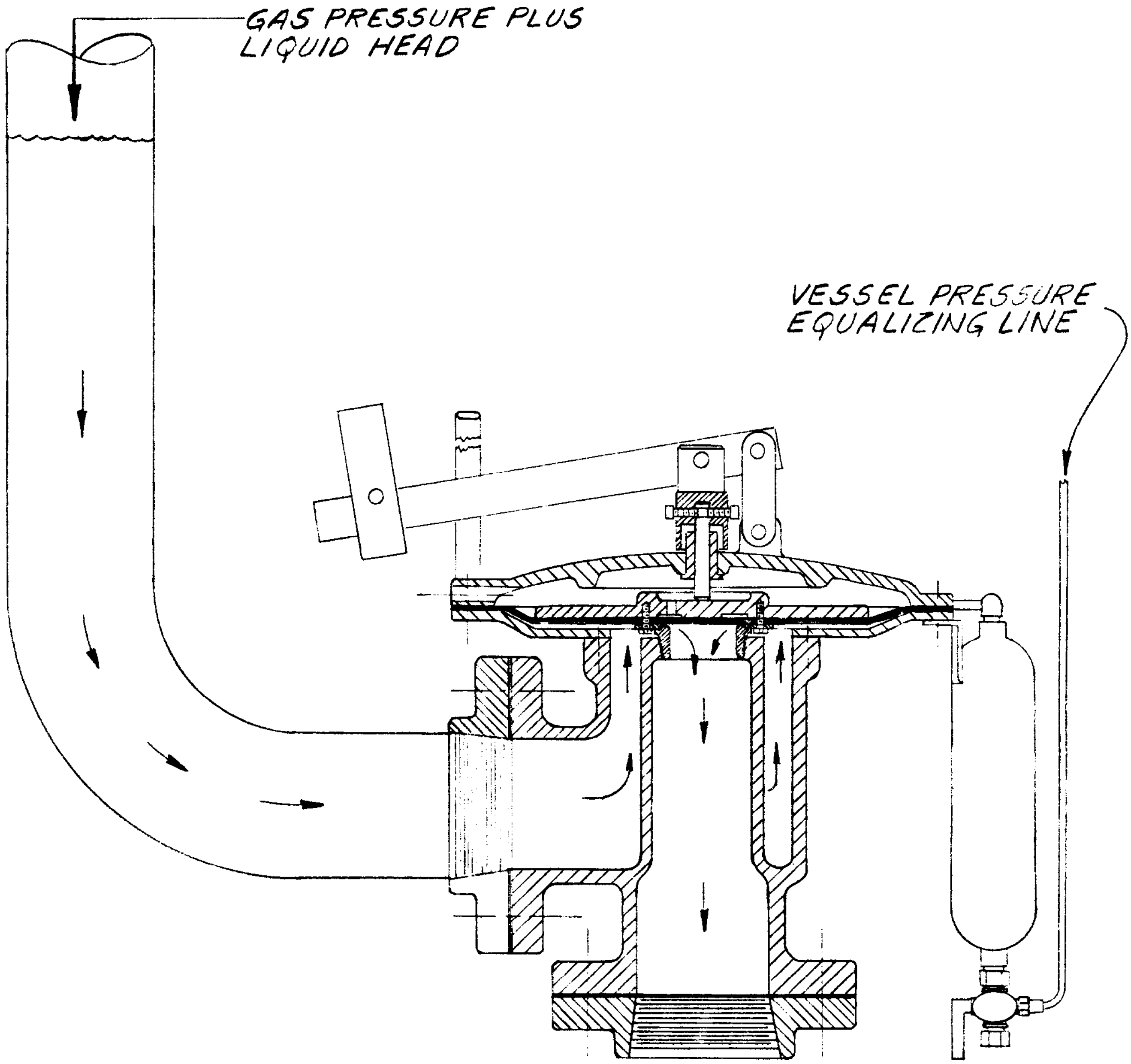
GAS PRESSURE PLUS
LIQUID HEAD
VESSEL PRESSURE
EQUALIZING LINE

Figure 3

section of a treater but reduces the amount of draft available for efficient burner operation. Firetubes and stack breeching should also be periodically inspected and cleaned.

It is recommended that the first firebox inspection be made 90 days after the firebox has been put into operation. The frequency of subsequent inspections should be based on the appearance of the firebox at the first inspection.

There have been instances where fireboxes were fired to the production as it came into the treater without first filling the treater with water. In many of these there have been early burn outs or breaks due to stresses. In one case fireboxes were burned out or cracked in 1 to 4 weeks for a period of about 3 months. The treater was then filled with water above the firebox. It was left in service for 60 days and less than 1/4-in. of scale formed. It was put back into service with water again over the firebox and used for six months with very little scale formation.

Next consider the filter section of the treater. If the treater has a filter section which is packed with excelsior, it should be thoroughly wetted with water just prior to putting the treater in operation. The filter section should be inspected occasionally for plugging. This will quite frequently show up as a gradual lowering of the oil-water interface due to pressure drop through the hay section. The drain valve should be opened periodically to drain accumulated sludge, sand, etc. from the bottom of the treater.

The water leg or siphon is probably the next important part to consider. There is not much to be done with this part before turning into the treater unless there are other treaters in the field from which the siphon setting may be obtained. After the treater is filled with fluid and the water is at approximately the correct position, the valve on the siphon may be opened and the siphon allowed to dump the water. If the oil-water interface is too low it may be raised by raising the internal pipe in the siphon. If too high, it may be lowered by lowering the internal pipe in the siphon. When changing the siphon setting the burner and pilot should be turned off. Siphons should be checked occasionally for scale formation especially if the interface in the treater starts to rise.

OPERATING PROBLEMS

One of the most frequent problems of operation is corrosion of the vessel. Corrosion in treaters is usually electrolytic and causes local pitting in the water section of the treater.

Corrosion can be stopped by use of anodes; either zinc, magnesium or graphite. Zinc and magnesium anodes are both sacrificial and must be replaced at regular intervals. However, they do not need an external source of electricity. The graphite anode must have a source of direct current to be applied to the anode but gives many times the service life of the magnesium or zinc.

Briefly, the action of the sacrificial anode can be explained very much like a car battery. The battery contains two different metals which are immersed in an electrolyte. This arrangement produces an electric voltage or potential and when the external poles are connected to a light or starter, electric current flows through the light or starter. It also flows on the inside of the battery from one metal through the electrolyte to the other metal. If the battery were not recharged the one metal or plate would completely dissolve and go into solution or deposit on the other plate.

An anode in a treater is very similar to the inside part of a battery. The steel shell and steel internals are one metal or plate and the anode is the other metal or plate, the salt water is a very good electrolyte. When a wire is attached to the anode and brought outside the treater and attached to the shell of the treater it forms the external circuit and current begins to flow. Due to the nature of the steel in comparison to the anode the current flowing through the water in the treater is from the anode to the treater shell. This causes the anode to slowly dissolve and go into solution and possibly to plate out on the steel. If this quantity of current is sufficient to overcome any stray electrical currents which are trying to go from one part of the steel to another part or to something else in the treater, then electrolytic corrosion will be halted.

The action of the graphite anode is the same except that it must have an external source of power applied to it to make the current pass from the anode through the water to the steel parts of the treater.

The amount of current necessary is dependent to a great extent on the type of water produced. In some fields corrosion is not a problem while in others, treaters must have anodes or they would be eaten up in a year's time. Waterflooding usually increases corrosion. Quite frequently a treater may work for several years with no apparent signs of corrosion, then waterflooding is started in that field and a treater very badly corrodes in less than a year. This is usually due to a type of bacteria which gets into the water on waterflood projects.

Treaters should be inspected periodically for corrosion and if found, steps taken to combat it immediately.

Another problem with treaters is sand. If it is known beforehand that sand is going to be present in the production it should be taken into account when selecting a treater. Sand jets or agitators placed in the water section of a treater are usually effective in keeping the bottom flushed of sand and sludge.

Foamy oil is also a serious problem with treaters. It can usually be handled by preheating the wellstream to some minimum temperature depending on the characteristics of the wellstream. The preheat may be accomplished by use of a heat exchanger, a preheater - heat exchanger combination, a preheater coil located in the water section of the treater or an external heater ahead of the treater on the wellstream. This preheat will reduce the viscosity of the crude oil and emulsion so that it will separate from the gas without excessive foam.

TROUBLE SHOOTING

A. When a treater is found to be maintaining its temperature and is operating correctly except that the water content of the treated oil is too high.
   1. Check the chemical pump to be sure it is operating and injecting the proper amount of chemical. An increased chemical input rate may be necessary because of wellstream changes.
   2. Check the location of the chemical pump. Relocation of the pump may be necessary for better mixing of the chemical with the influent emulsion.
   3. Changing conditions of the wellstream may necessitate a change in the chemical compound. After the field of available chemicals is narrowed to one or two by bottle testing, a field test normally provides the only sure selection of the best chemical.
   4. Check for foaming oil being carried out the vent line. This will usually indicate that emulsion in the form of foam is by-passing the settling section. The use of emulsion preheater is strongly recommended for severe foaming. There is a sample cock on some treaters in the gas section just below the elevation of the top of the gas equalizer on vertical treaters, this should be checked for foam.
   5. Check the temperatures of the oil in the settling section. Sometimes due to low flow rates the oil cools off in the settling section before the water has settled out. Insulation of the settling section will usually help. If the treater does not have a filter section, the oil level could be raised. This would decrease settling time but increase initial temperature due to longer contact with hot water and increase settling temperature.
   6. If filter section is used it should be checked for channelling and probably repacked.

B. When it is found that a treater is not able to keep the treating temperature at the desired level.

1. If the firebox is firing continuously and the desired oil temperature cannot be maintained, make an accurate check of the oil and water production, together with their respective inlet and outlet temperatures. It normally requires about 150 BTU's to raise the temperature of one barrel of oil one degree Fahrenheit and about twice as much for one barrel of water. If - on this basis of calculation - the heat input to the fluid is not appreciably less than the firebox rating, the treater is overloaded. The heat load should be based on small increments of time as 15 minutes, and on continuous flow during the increment of time, not on daily flow rate.
2. If the treater is overloaded, check the heat input to the water. If an undue amount of heat is being put into the water, one of the following solutions may exist:
   a. A change in chemical may promote more rapid separation of free water in the treater.
   b. The installation of a separate free water knockout may sufficiently reduce the heating load.
   c. On horizontal treater, the oil-water interface may be lowered slightly. It should be below the bottom of the steam chest.
3. If the calculations indicate that the firebox is not overloaded, inspect the firebox for internal soot deposition and external salt, sand and mud deposition.
4. Check the fuel gas supply. The BTU rating of the fuel gas may be too low. Fuel gas pressure should be approximately 10 psi.
5. Check orifice sizes in the burner, if too small drill to larger size or replace with larger size orifices.

C. When oil is going to stock tank cold and untreated but temperature and fire are all right on treater.
   1. Check the treater for plugged downcomer from gas separation section to bottom of treater. On some treaters the sample cock just below the top head seam can be used to check this, if downcomer is plugged, oil will be above sample cock.

D. If temperature of treater or interface in treater changes appreciably during recirculation of bottoms.
   1. There is always a good sign of excessive recirculation rates. The recirculating pump should be slowed down. Quite frequently it is a much tougher job to treat tank bottoms than to treat new crude.

E. When the oil-water interface is found to be increasing in height.
   1. Check the operation of the water discharge valve to be sure that it is opening properly.
   2. Check the water discharge valve internally for deposition of salt which may be restricting the flow of water.
   3. Check the salt water discharge downstream from the valve for restrictions or back pressure. (In case of discharge to a disposal plant).
   4. Check for accumulation of sediment in the bottom of the treater which would stop the flow of water into the water outlet line. It is generally a good practice to flush the bottoms of the treaters regularly to prevent the accumulation of sediment. In cases where sand is encountered the installation of sand jets is recommended.
   5. Check water siphon for scale and deposits which would restrict flow.

F. When the oil-water interface is found to be decreasing in height:
   1. Check the oil level in the settling section.
      a. If the oil level is above the top of the oil outlet:
         (1) Check for loss of pressure on the treater.
         (2) Check for restrictions in the oil discharge line, as paraffin deposition, all tank manifold valves closed, etc.
         (3) Check drip pots on oil valve. If they are filled with liquid the oil valve will close and remain shut.
         (4) Check the filter section to see if it is plugged, particularly where heavy asphaltic oil is being treated.
         (5) Check for excessive recirculation of tank bottoms. It may be necessary to decrease the size or speed of the circulating pump when recirculating tank bottoms.
      b. If the oil level has not risen above the oil outlet:
         (1) Check the chemical injection. The degree of treatment may have suffered and the water content of the oil in the settling section above the oil-water interface has increased.
         (2) Check the treating temperature. When the temperature decreases the specific gravity of the oil increases, also the width of the emulsion band increases. Thus, the oil-water interface is lowered due to this increase in specific gravity.

G. When it is found that oil is being dumped with the water:
   1. Check the chemical pump. A change in chemical compound or amount may promote more rapid separation of water in the treater.
   2. Check the treating temperature. Additional heat may be necessary to break the emulsions and allow the water to separate quicker.
   3. Sand will sometimes carry down small amounts of oil with it which goes out with the water.

H. When frequent pilot light failures are encountered:
   1. Be sure that the pilot gas is dry. A combination drip and filter is normally used.
   2. Check the location of the pilot light to be sure that it will properly ignite the gas from the main burner without being subjected to undue drafts when the main burner goes off or on.
   3. Be sure gas air mixture is such as to give a stable flame per manufacturers recommendations.
   4. Clean pilots periodically to insure proper operation.