APPENDIX E

CHEMICAL TREATMENT

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SPECIAL INFORMATION ABOUT CHEMICAL PUMPS

E1-1. The Principles of Chemical Pumps and Injectors.

Chemical pumps can be a great help in treating oil, or they can be nothing but trouble if the lease pumper does not understand how they work and does not keep them repaired and adjusted correctly. When they are in good shape they will save time and help keep the oil properly treated.

The heart of the chemical pump is the chemical injector. The body of the injector is made of forged steel. The chemical must move upward through the injector to prevent air locks. When the body of the pump is worn due to plunger friction, it can be machined out oversize and last many more years with a larger plunger.

Figure 1 shows a typical injector. The numbers in the following paragraphs refer to the part labels in the illustration.

The plunger moves back and forth in a reciprocating action. As it moves back, vacuum lifts the lower ball check valve (13, bottom) open, pulling fluid in from the chemical reserve tank. The plunger can be pulled back by a gear (5) or have a pin dropped in through a hole.

As the plunger is pushed back into the injector, the upper ball check valve (13, top) is opened by the pressure on the chemical, and the chemical is injected into the oil being treated.

The plunger stem packing nut (12) must be tightened a small amount occasionally to keep the packing (4) tight to form a seal against the plunger. This packing will have to be replaced every few years to prevent chemical loss and air locks. To remove air locks from between the two ball valves, while the plunger is being pulled out the air bleeder rod (11) must be kept closed, and while the plunger is being pushed back in, the air bleeder rod (11) should be opened so that the air can be removed.


Mechanical chemical injectors are usually located at the well site mounted on the base of the mechanical pumping unit. This pump has been very popular through the years and gives good service.

Mechanical injectors are usually driven by the use of a flexible line to lift the arm and a weight to lower it. In years past, steel
reinforcement rods were popular, but if the lease pumper placed an arm or leg under the rod on the downstroke, serious injuries were possible. The upper end is attached to the H-section of the walking beam and can be moved away from the saddle bearing for a longer stroke or closer for a shorter stroke.

The mechanical chemical injector in Figure 2 would work well when a surfactant must be injected for oil treating, and paraffin solvent must be injected down the casing to reduce paraffin accumulation downhole.

![Figure 2. A mechanical chemical injector that is installed on the pumping unit. (courtesy of Arrow Specialty Co.)](image)

**E1-3. The Low-Pressure Pneumatic Injector.**

The low-pressure chemical injector is utilized where very low gas pressure is available. If a tank battery has no high-pressure vessels, such as a separator, but has only a gun barrel and stock tanks, chemical may be injected mechanically and accurately with the low-pressure pneumatic pump. By installing 2- to 4-ounce backpressure valves on an atmospheric vessel gas vent, this pressure can be used to operate the injector as well as to control the vapor recovery unit.

Figure 3 shows that the pneumatic gas enters on the left side to operate the large diaphragm, and the chemical enters the chemical injector on the right side of the picture. This unit is then mounted on some type of base.

It is easy to compute the force the diaphragm pump will exert in pounds per square inches using the formula:

\[
\text{Pressure} = \pi \times \text{Radius}^2 \times \text{Pressure in lbs.}
\]

If the diaphragm is 18 inches across and the gas pressure is 4 ounces, then

\[
\text{Pressure} = (3.14) \times (9 \times 9 \text{ inches}) \times \frac{1}{4} \text{ pound}
\]

\[
= (3.14) \times (81) \times (\frac{1}{4})
\]

\[
= 63.6 \text{ pounds per square inch}
\]

This is the pressure on the plunger. Since the plunger occupies no more than 1/3 of a square inch, 4 ounces of pressure can produce tremendous force.

Low pressure pneumatic injectors can be used for as long as they are maintained. There are few parts to replace, and the lease pumper should be able to keep them functioning if no mechanical assistance is available.
E1-4. The High-Pressure Pneumatic Injector.

The high-pressure pneumatic injector has many applications in the oil field other than treating crude oil. Since it operates under high pressure, it is used on flowing wellheads, gas wells, pumping wells, and many other applications.

A typical high-pressure pneumatic injector is shown in Figure 4. The two high-pressure brass cylinders that stick out from the square cast iron body of the pump contain a soft-faced piston and have a hollow connecting rod. The gas is injected slowly into the space outside the end of the piston and this pushes it toward the square body. As the opposite piston approaches the end of its stroke, it engages a reversing valve that relieves the pressure from the end that just completed its stroke and places pressure against the surface of the opposite piston.

As shown in Figure 5, three speed adjustments are available. The first adjustment is opening the bent arm of the inlet needle valve handle. This stem has a set nut so that it can be locked at the desired inlet volume. A second adjustment changes the hole that has an arm going to the adjustment plate. The third adjustment is to change a pin that regulates the length of the stroke of the piston.

When this injector is installed on a flowing oil or gas well that has a bottom hole packer in it where no annulus gas pressure is available, a round cylinder similar to the surge tank used to prevent fluid shock to triplex pumps is installed as a gas volume tank on top of the wellhead. Even when flowing a high volume of crude oil, enough gas will break out of the oil being produced and rise in the cylinder to operate the injection pump.

High-pressure injector pumps are used extensively in the production of natural gas for injecting such solutions as tri-ethyl glycol (TEG), ethyl glycol (EG), and methanol.

When using a high-pressure chemical injector, the lease pumper should compute the injected volume every few days in order to ensure that the oil is being correctly treated.
E1-5. The Electrical Injector Pump.

The electrically driven chemical pump usually has fewer problems than the other systems. It also has the advantage of being programmable by use of the electric clock. Since electricity is required, this system is not possible or practical for many installations.

For a high-volume tank battery with several pieces of equipment driven by electricity, such as the circulating pump, vapor recovery unit, and the LACT, the chemical injectors can also be electrical (Figure 6).

E1-6. The New Style of Chemical Pumps.

During the past decade, great strides have been made in the development of improved injector pumps, including the use of inexpensive computer cards to automatically control pump volume. Ease of operation, simplicity in style, and low cost have led to growing sales for these enhanced models, although the older designs are still in demand.

For example, the Gas-O-Matic style chemical injector discussed in Chapter 13-C has become very popular during the past few years and is capturing much of the market (Figure 7). This system can be powered by gas or air.

Figure 6. Views of an electrically driven high-pressure chemical injector.
(courtesy of Arrow Specialty Co.)

Figure 7. Diagram of the Gas-O-Matic injector valve.
(courtesy of Arrow Specialty Co.)
E1-7. **Barrel Racks and Bulk Storage Containers.**

Barrel racks and bulk storage containers along with accessories like sight gauges and chemical injectors are illustrated in Figures 8 and 9.

The 55-gallon drum and rack system remains popular for smaller installations, but in larger fields, a bulk storage container is generally installed and filled by a chemical supplier. With this system, the lease pumper does not have to handle heavy barrels or become involved in blending large volumes of chemicals. Also, bulk purchases are usually cheaper than the cost of the drums.

Bulk storage containers can be purchased in fiberglass, stainless steel, and other materials. Fiberglass is the most common because of the low cost and because the amount of chemical remaining can be determined at a glance.

![Figure 8. A fiberglass storage tank with knee tub and injector. (courtesy of Arrow Specialty Co.)](image1)

![Figure 9. Chemical barrel and rack with liquid level gauge and injector. (courtesy of Arrow Specialty Co.)](image2)

Chemical tanks, injectors, and the quality of chemical have been greatly improved over the past few years and regulations to protect the lease pumper have also been modified.
The Lease Pumper’s Handbook

Appendix E
Chemical Treatment

Section 2

SOLVING SPECIAL TREATING PROBLEMS

E2-1. Location, Installation, Operation and Maintenance of Chemical Injectors.

Once the determination has been made to use chemical injection, the lease pumper must then decide how to stabilize and mount the injection equipment. Many mechanical injectors can be easily mounted on the front of the pumping unit base (Figure 1).

Figure 1. A mechanical chemical injector mounted directly to the base of the pumping unit.

When the chemical injector is located on the ground near a chemical tank, it is usually set on a concrete base (Figure 2). If the pump is placed on a board or on a graveled surface, weeds will soon engulf the whole installation, and it will be difficult to keep clean. When a concrete pad is used, the concrete should extend at least six inches beyond the edges of the chemical injector on all four sides.

Figure 2. Chemical tanks and injectors set on a concrete base.

E2-2. Treating Oil: A Review.

There are numerous chemical injector designs to support the various approaches to chemical injection (Figure 3).

Figure 3. Types of chemical injectors.
Some of the more common methods of treating oil include:

**Injecting chemical at the wellhead downhole.** This includes injecting the chemical into the annulus and allowing it to flow downhole. By circulating a small amount of produced liquid from the bleeder side of the pumping tee to supplement the volume of injected chemical, it will reach the bottom of the hole in a reasonable length of time. This procedure is important in:

- **Treating crude oil.** The treatment will begin as the injected chemical mixes with the fluids entering the annulus from the formation.

- **Treating corrosion and scale.** This treatment will keep the casing and tubing perforations open, as well as keeping the inside of the tubing and the rod string clean.

- **Injecting paraffin solvent.** As the fluid travels up through the tubing, the melted paraffin begins to stick to the rods and tubing and accumulate in the well. Paraffin can accumulate and become so stiff and hard that it can support the weight of the rod string, so that the rods fall slowly on the downstroke. The horse head bridle and carrier bar will run out from under the polished rod clamp on the downstroke, and this causes tremendous shock when the pumping unit again accepts the rod load. Occasionally hot oil must be injected to allow the paraffin to become a fluid again and be pumped to the tank battery. This widely used practice can plug perforations and the formation. Chemical treatment has proven to be far superior to hot oiling.

**Injecting chemical into the flow line.** All of the chemicals injected into the annulus can also be injected into the flow line to achieve the same goals in the flow line as achieved downhole.

**Injecting chemical at the tank battery.** Chemical is injected at the tank battery after the header but before the first pressure vessel. The primary purpose in injecting chemical at this point is to treat the oil. This is the first location in the system at which the injected chemical will treat all of the oil being produced.

**Dripping chemical into the thief hatch.** Dripping chemical into the thief hatch from a gallon bucket with a very small hole in the bottom while circulating the oil will stimulate BS&W removal dramatically. The action of circulating without adding chemical will also assist in cleaning the oil. After treatment, the fluids will need a satisfactory amount of settling time, usually until the following day.

**Hot oiling the oil in the tank.** Calling out a hot oil unit to treat oil from stripper wells is sometimes necessary, but this is an emergency treating procedure and is seldom done if other solutions can be found. This is because the margin of profit is so low that expenses may exceed income.

**E2-3. Other Treating Procedures That Have Not Been Reviewed.**

There are many ways of reducing the BS&W level in oil that have not been discussed in this manual. A purpose of this section is to provide information about designing and implementing additional innovative procedures that will assist in solving treating problems. Occasionally
small changes in the piping may have to be made and openings and valves installed to make the tank battery piping arrangement accommodate an oil treating procedure.

**Batch treating down the annulus.** Occasionally it will be necessary to address a downhole problem by batch treating oil, scale, corrosion, or other problems. Figure 4 shows one shop-made style of treating trailer. The lease pumper can pour in the correct amount of chemical, then finish filling the tank with water or crude oil. Three or more wells can be treated with one tank load.

![Figure 4. A chemical tank and pump mounted on a tandem-axle trailer for injecting chemical and oil or water into the annulus.](image)

**Batch treating and circulating.** With many wells, after batch treatment, it may be desirable to open a circulating line going from the flow line into the annulus. To allow circulation, the valve from the flow line is opened to permit the produced fluid to fall back to the bottom of the well. The flow line valve to the tank battery is closed while circulating. The lease pumper may circulate the oil for several hours or some appropriate time, then switch it back to normal operation. Occasionally, this treatment may also require a shut-in period or an overnight circulating treatment. Batch treatment may be done once a month or on some set time schedule.

Some lease operators will contract with a chemical company to treat and circulate the wells on a regular basis. It takes a very productive lease to be able to have the available funds to subscribe to this service.

**E2-4. Batch Treating the Heater/Treater.**

Occasionally, the lease pumper may need to send an extra slug of chemical to the tank battery to inject extra chemical throughout the heater/treater to bring the system back into balance and treat exceptionally bad oil created in the system by some special activity such as a well workover.

The chemical must be pumped in at the oil entry opening. Because there are two ways of producing into the vessel the treatment must be either from the well or from the tank battery.

**Method 1: From the well.** There are several ways of injecting a batch treatment of chemical from the well. To batch treat, the lease pumper will add 2-4 quarts of additional chemical to the heater/treater. A small \(\frac{1}{2}\) -inch positive displacement pump with a hand crank to drive it can be mounted on a small frame stand. First, a \(\frac{1}{2}\) inch x 3 inch swage is screwed into the inlet opening using a street ell. With the opening of the swage up and a small hose connected to the bleeder valve, a batch treatment of chemical can be injected.

Another method is to install a standing riser ahead of the heater/treater inlet a few feet before it enters the vessel. By installing a tee in the running position in the line just ahead of the heater/treater, installing a nipple and valve pointed up, a 4-foot piece
of pipe, then a bell reducer on top with a quarter-inch bleed off valve, a surge tank that also injects chemical is installed.

**Method 2: From the tank battery.** Some operators bury a drum behind the tank battery with only two inches of the top above ground. Chemical can be poured into the 2-inch opening, then the barrel filled by a small hose attached to the drain line. The hose is small enough to reach the bottom of the drum to mix the chemical with the oil.

When the level in the drum is almost full, the tank valve is closed and the hose lowered to near the bottom of the drum. By turning the circulating pump on, this chemically enriched mixture is sucked out of the drum and into the line to the tank battery. The line to the drum is closed and the tank drain opened long enough to circulate the chemical into the heater/treater. The pump is then turned off so that the chemical will remain in the heater/treater long enough to give it a soak time treatment.

Giving the heater/treater a boost treatment can restore much of its treating ability when it gets overloaded with BS&W. This situation occurs when there has been undertreating of the oil over a period of time, especially in the summer when the heat is turned off and the heater/treater is being used as a three-phase separator or a gun barrel. By discussing the problem with a supervisor, the lease pumper can probably find an economical solution that is possible with any battery line arrangement.

**E2-5. Treating High Tank Bottoms by Circulating with Pump and Hoses.**

Most tank batteries can develop high tank battery bottoms that interfere with selling oil. Sometimes circulating tank bottoms regularly and after selling every tank is not enough. The bottoms build up and the tank of oil cannot be treated low enough.

The drain in a tank should have a line inside that extends across the tank to a location near the thief hatch. Otherwise, circulating creates a small clear area at the back while the front still has a 10 inch bottom.

**Suitable portable circulating pumps.** The operator must back the lease pumper’s actions in developing methods for one person to treat the bottom of the tanks. This is especially true when using a portable circulating pump that must be moved from battery to battery by hand loading it into the pickup. Skid pumps are too bulky and heavy. The unit with the 1½” centrifugal pump imounted directly on the motor can be lifted with one hand. By placing a swage and union on each opening and a valve on each hose with both unions facing toward the pump, the hoses can be hooked up to the tank drain and a stinger line of 1” PVC stuck down into the tank. By merely closing the two valves on the hoses and loosening the unions, the pump may be turned around to pump in the opposite direction in a few minutes.

**Stirring high bottoms during treatment.**

When stirring bottoms during treatment, the lease pumper needs to place the added chemical in the bottom of the tank at the front, right into the emulsion. To stir a high bottom, the first thing to do is produce into the tank long enough that at least 1-2 feet of fresh oil is above the emulsion.

The second step is to stand a small PVC line up through the hatch. If the bottom of the PVC tube is cut at an angle, it will not seal against the bottom. A quart of chemical can then be poured through a funnel into the
tube. By placing chemical in several locations, the chemical is in the bottom of the tank, right in the emulsion.

With the pump hose connected to the PVC and inlet pump hose fastened to the tank drain line, the lease pumper can start the pump and inject the stream of oil directly into the bottom emulsion. By moving the bottom of the PVC to new areas and toward the back of the tank, eight inches of emulsion will grow by several inches as it is stirred. By stopping the engine and turning it around occasionally, the emulsion is pulled from the front and injected into the back. The lease pumper can also send the oil through the heater/treater, and, if necessary, fire up the heater/treater to warm the oil. If only a gun barrel is available with no heat, this vessel will also do a good job in most situations. If neither vessel is available, the lease pumper can treat it in both directions, shut it down, leave it, and then bleed off any separated water the next day and do it again. This is a problem that must be addressed regularly in order to have clean bottoms. Clean bottoms are bottoms with no more than 5 inches of BS&W.

When a high bottom is accumulated that is difficult to treat, the lease pumper may have to sell from the second tank until the first is clean. This may take several treatments with the pump and the tube down the hatch.

Regardless of the volume of oil that is produced, chemical is expensive, and oil can be difficult to treat. After trying various methods to treat oil, each try becomes easier.

NOTE: Large volumes of chemical introduced into small volumes of BS&W can cause a condition known as burned oil. The oil is over-treated and cannot be corrected. The lease pumper must be careful not to burn oil when trying to treat bad tank bottoms.