Care and Maintenance of Injection Pumps

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Your injection pump is the heart of your waterflood or salt-water-disposal injection system. We, realizing the necessity of continuous injection in a flood, will attempt to pass on information based on past experience and observation that will aid, through proper maintenance, to keep your pump in operation.

We have broken down the care and maintenance into essentially three catagories: fluid end maintenance, power end maintenance, and maintenance in general.

Taking these in order, we shall first take a look at fluid end maintenance. The plungers and packing seem to require more maintenance than do any other items in an injection pump. We believe that plungers and packing have to be selected on the basis of information known of the operating conditions, the fluid to be handled, and numerous other factors that affect plunger and packing life.

Despite the fact that no one has an answer, some exceptionally long runs have been attained by proper maintenance. We quote from an article by Steve Elonka, Associate Editor of *Power:*

> The man with the wrench can be a dangerous person in your plant: responsible for scored rods, excessive down time, wasted packing. The reason is simple. Few operators really understand how packings work, especially 'jam' types, forced against a wearing surface by gland nuts.

Overtightening not only causes more rapid wear and shorter life of component parts but also requires additional horsepower to accomplish the same job because of the frictional drag imposed on the plunger rod.

In one instance we found that proper installation and proper adjustment increased the volume of fluid handled by some two percent, at a saving in electric power consumed, by reducing the frictional drag of the packing and increased the life of the packing by 400%.

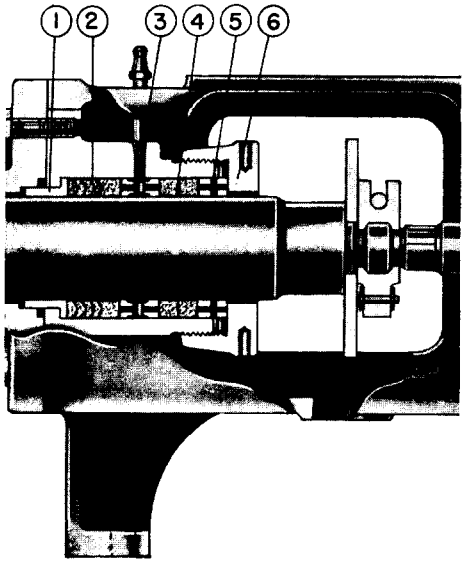

Figure 1. Cross Section of a Typical Stuffing Box and Plunger

1. Bushing
2. V-type packing
3. Lantern ring
4. Packing rings
5. Gland follower
6. Packing gland

Fig. 1 shows a cross section of a typical stuffing box and plunger of a 4-in. triplex plunger pump. Number one is the stuffing box bushing, which is made of bronze when used in an aluminum bronze fluid end. It supports the packing and presents a flat, renewable surface to the adapter ring of the packing. It is most important that this bushing be pushed all the way into the stuffing box in order to be sure that it is completely straight and properly seated.

Number two is the sealing part of the packing, consisting of the bottom adapter ring, which helps to spread the lips of the V-rings as well as helps to support the packing. The V-ring nearest the outside does most of the packing and normally is the first to fail.

Number three is the lantern or spacer ring, which carries the lubricant to the plunger and helps to support the thrust of the packing.

Number four is the hydraulic packing rings, which help support the weight of the plunger assembly and give support to thrust on the packing.

Number five is a thrust ring. Its purpose is to allow the gland Number 6 to be tightened without disturbing or twisting the other component parts of the packing.

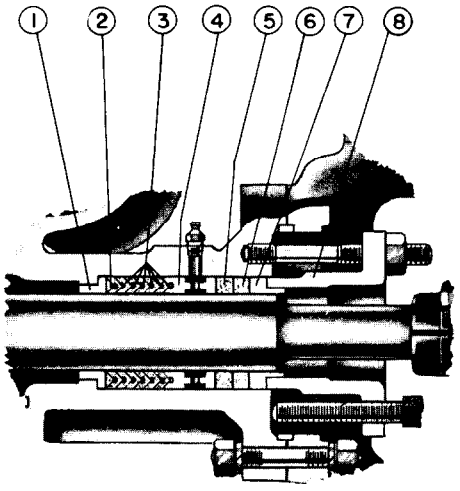

Figure 2. Plunger Packing

1. Bushing
2. Bottom-adapter ring
3. V-type packing
4. Lantern ring
5. Packing ring
6. Packing ring
7. Bushing
8. Packing gland

Fig. 2 shows another stuffing box system that is sometimes used. It differs from the first in the fact that it has a three-bolt-type gland and a stuffing box, it is integral with the fluid end, and it shows a different brand of packing.

How do we go about getting the most from our packing? Most injection pumps for waterflood use this automatic type of packing of the V-ring lip type or variations of this type. When this packing is used in repacking the rules for longer life are simple and easily remembered:

1. Clean all old packing out of the stuffing box.
2. Thoroughly clean the stuffing box, the bushings, and the lantern ring. Remove any salt or scale built up in the bore of the stuffing box and make sure that no burrs are in the metal bushings and the rings.
3. Grease each packing ring and insert each ring separately, pushing the rings to the bottom of the stuffing box with a block of wood. Be sure that each ring is firmly seated before putting in the next ring. Do not push these rings down with metal punches

or pipe nipples. These can ruin the packing before it is even run.

4. If the packing is installed by the instructions above, the packing has already been adjusted before the gland is put in place. Just tighten the glands sufficiently to hold the packing in place.
5. Inspect the plunger for nicks, burrs, or chipped places. Then grease the plunger thoroughly before inserting it through the packing.
6. Packing should leak with a constant drip at all times, especially at 700 to 800 pounds of pressure or higher. Most packing will leak more when the pump is not in operation. If additional adjustment is required, check after 4 to 6 hours of operation, because most packing swells slightly and requires backing off of the gland. Back off only a small amount -- say about 1/64-in. to 1/32-in. in order to give proper adjustment. Do not back off so much that the packing moves in the stuffing box. If packing fails on the OD this failure indicates movement of packing in the stuffing box and it can cause the stuffing box to be rapidly grooved out, causing a premature failure of both packing and stuffing box.
7. If gland locks are provided, be sure that they are secured at all times when the pump is in operation. If a gland backs off during operation, it can cause a very expensive wreck of the pump.

PLUNGERS

Most of the plungers in use in the injection pumps are either stainless steel, ceramic, or metalic coated, such as Colmonoy. Stainless steels have given good service in lower pressure ranges, but because of their inherent softness, they tend to groove rather rapidly at higher pressures and are more seriously affected by corrosion than other types are.

The ceramic plungers in use require care in handling because of their extreme brittleness and low tensile strength. They are superior in corrosive resistance and in hardness, and they retain a smooth finish for long periods of time. They will break in service if any side load is imposed on them. They are not recommended for high temperature service.

Colmonoy has good corrosive resistance and is hard enough to give long packing life and to retain a smooth finish. Since the coating is put on steel plungers, it does not have the fragility that the ceramics have. Another advantage of Colmonoy is its cost; normally Colmonoy is much less expensive than the ceramic type of plunger.

Almost any of the plungers in use can be ruined if allowed to rub on the bushings or the lantern ring in the stuffing box.

The clamping arrangement of the plunger should be daily inspected to prevent any slack. Since each plunger has a load of 5000 pounds to 20,000 pounds, according to the type of pump it is operating in, one can visualize the result of any looseness in the method of retaining the plunger. Slight movement can give tremendous shock loads, not only on the plunger shank connection but also on the power end of the pump.

Further instructions on the care of the plunger include the following: Always thoroughly clean the shank of the plunger and the extension rod or part that connects to the plunger shank before you re-assemble the parts. Remove any burrs or dirt with a wire brush and file. Check to be sure that the parts line up before you clamp them. Do not use chipped or broken plungers because they will cut out a new set of packing in a short time.

One problem with which we are faced in this area is the tendency for the fluid leaking through the packing to evaporate, leaving a layer of salt crystals or scale on the plunger. This build up can then be pushed through the packing and can cut a set of packing out very rapidly. If a pump is shut down for any length of time, the plungers should have this build up washed off before it is started up. Lubricating the packing with an oil containing 3% to 10% tallow or other animal fat can help eliminate this problem. This oil not only gives longer packing life but keeps a coating of tallow on the plunger to help keep the salt or scale from sticking to the plunger. In addition, it is recommended that the accumulation of sale be washed off once a week or as often as necessary.

One operator, having washed all of the salt off the exposed pump parts and plungers, puts on a coating of inhibitor. He mixes this inhibitor with kerosene and uses a common oil can to coat all the pump parts. This coating helps to keep corrosion to a minimum.

GASKETS

The next point that we will take up is gaskets. In order for a gasket to seal effectively, not only must it be clean but the surfaces it works against must also be clean and free of scale and rust. Compression-type gaskets used in some pumps may be used in worn or corroded surfaces, but one must be very careful in order to get an effective seal. Cylinder head and valve cover studs should be thoroughly cleaned, and the threads should be lubricated before these covers are put into place. The nuts should always be pulled evenly and not tighten around the circle, but one stud should first be tightened and then the 180 degrees opposite from it should be tightened. For me to suggest that all studs and bolts on a pump should be torqued would be completely out of reason, but actually they should be. The next best thing is to have a man using the wrench who realizes when he is tightening a 5/8-in. or 3/4-in. stud that he does not need a 5-foot cheater pipe on his wrench in order to get it sufficiently tight. Overtightening and uneven tightening have caused quite a number of failures of gasketed joints in pumps.

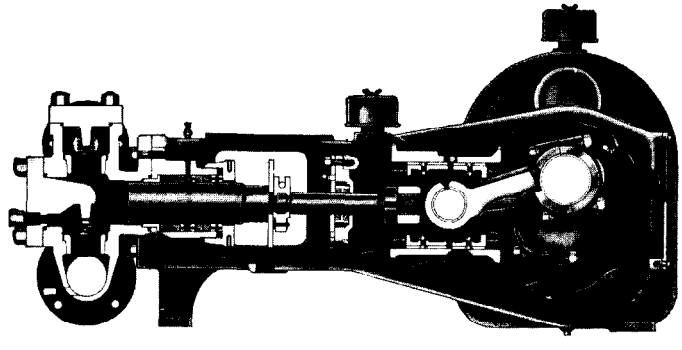

Figure 3

Many pumps are now using "O" rings as gaskets. An "O" ring must be in a groove with a rather close tolerance. If it is installed in a dirty groove or in a groove that has a certain amount of rust and scale built up in it, the "O" ring will fail prematurely.

Instructions concerning the O-rings are as follows:

Always thoroughly clean with a wire brush and wipe clean and dry the groove that the "O" ring is to work in. Grease the "O" ring with some type of light lubricant before putting it in place so that it will have a chance to seat and to seal off. Do not use two gaskets or a gasket that is thicker than the one originally supplied with the pump. This will present such a large surface area to the pressure that you will be unable to keep the gasket in place. A thin gasket is much better than a thick one when the gasket is subjected to pressure.

Next in order of frequency of replacement is the valve system. Since each valve goes through a full cycle of operation for each revolution of the crankshaft, the valves are subjected to considerable wear.

The types and materials used in injection pump valves are numerous. They range in valve types from metal-to-metal valves, rubber-sealed or slush-type valves, through non-metallic disc-type valves. Materials may be bronze,

aluminum-bronze, various stainless steels, monel, bakelite, nylon and variations of each of these materials.

In order for a valve to function properly it must not only seal off the fluid but also act in such a manner that it cuts off the flow through it or the attempted back flow. If this cut-off is abrupt, it will cause a water hammer in the pump, resulting in a considerably shortened valve life.

Valve seats that depend on a metal-to-metal seal in the fluid end deck should be thoroughly cleaned before being installed. The valve deck bores should be clean and dry. The seats should be driven into the valve deck by using a steel plate on top of the valve seat or a short piece of pipe on top of the valve. Oil or any other type of lubricant should never be used on the valve seats or on the valve deck.

Metal-to-metal sealing valves with a tapered seating surface should always be lapped in after the seats are in place. A fine grade of valve-grinding compound should be used. Slight pitting of a seat or a valve can be removed by using a valve-grinding compound. Rubber-sealed or slush-pump-type valves can be renewed by replacing the rubber insert.

Some of the plate-type valves can be used after they have failed on one side by turning the plate over to give a new wearing surface.

It is not always necessary to shut a pump down in order to check the valves. A leaky valve gives a distinct hissing sound. This can be heard by putting a pencil, a screwdriver, or a piece of wood in the teeth and by putting the opposite end on the valve cover. There are several devices on the market to aid in locating sounds, but so far, we have found that we can hear better and tell more what is going on by using the above method than we can with a fancy stethoscope.

Broken and bent valve springs give some trouble in injection pumps. These should always be replaced when found because of the erratic valve action they cause.

Any change in noise of a pump from the normal sound can usually be traced to valves or valve springs, provided that the suction line is open and that fluid is getting to the pump.

Corrosion of valve springs cannot be tolerated because of the relatively high stress they operate under. For this reason, most springs are now made of one of the monels, which seem to resist corrosion.

Some manufacturers can give a choice of several types and materials in valve service. The valve that gives satisfactory performance in one application may not last a month in another similar system. Water analysis can give a clue to the type of materials one should select for a given application, but many times, water changes during the life of the flood, causing corrosion trouble not experienced before.

We shall now discuss the part of the pump that normally no one has any trouble with, or at least very little trouble--the power end. One of the most important points to be remembered in the servicing of the power end is the lubrication. All pump manufacturers recommend a regular oil change, normally, at a maximum of six months. Many pumps in the field have probably run from two to three years and have never had the oil changed. One should always check the manufacturer's instruction that comes with the pump or can be found on the pump for the type and quantity of oil used. This will range from 30-weight motor oil through 50-weight motor oil. Some manufacturers recommend a 90-weight gear oil. The type of oil recommended should always be used. After all, the people that build the pump should know more about the type of lubricant required in order to furnish lubrication for their particular type of bearings and working surfaces than anyone else does. Should an oil not recommended be used and a premature failure of a bearing occur, the manufacturer will be very reluctant to replace the parts that have failed.

The oil level should be checked daily. The shut down static oil level and the running oil level should be determined, because it is not always feasible to shut down a pump and wait for the level to become static. A crankcase should not be over filled, because the excess oil may be thrown out through the seals and the gaskets.

Since we are dealing with a machine that is handling, to say the least, a corrosive and sometimes just down right rotten water, we would suggest that periodic checks be made for water in the crank case oil. Water is a very poor lubricant and can cause extensive damage, if left in the oil and in the crankcase of the pump.

The crankcase of the pump should be thoroughly washed out after every other oil change or at least once a year. On pressure-lubricated pumps, the suction screen of the oil pump should always be checked. Many times a drop in oil pressure can be found when this suction screen gets clogged up.

We would suggest that periodic bearing adjustments and inspections be made of the power ends. Since most of these pumps are equipped with tapered roller bearings, and it is a well known fact that a tapered roller bearing will run for many years if kept properly adjusted, we feel that this cost can be justified. Most of these pumps operate with an automotive type of connecting rod bearing, that is, the replaceable-insert type. Some of these inserts are adjustable and some are of the precision type. At any rate, if these are replaced when they are worn out, you can in most cases save the cost of a new crankshaft. If you continue to operate with loose inserts in the pump, normally, the crankshaft will get out of round and will become grooved necessitating a replacement, which can be very expensive and will require a shutdown of about 6 to 8 hours at a minimum.

Crossheads in these pumps give very little trouble but should be checked to determine wear, clearance, and condition. Some pumps have adjustable crossheads that can be kept at the proper clearance by adding or removing shims.

GENERAL INSTRUCTIONS FOR MAINTENANCE

Any piece of equipment in the oil field requires certain periodic maintenance in order to give satisfactory performance.

Daily checks of your injection pumps should include:

1. Crankcase oil level -- check for water in the crankcase.
2. Lubricate packing if equipped with gun-type lubricator or check oil level in mechanical lubricator if used.
3. Check packing for abnormal leakage.
4. Check for any movement of the component parts of the pump due to the loosening of the bolted connections. Keep all bolts and capscrews tight.
5. Lubricate diaphragm oil seal stuffing boxes.

PERIODIC CHECKS

1. Change the crankcase oil according to the manufacturer's recommendations, usually stating a maximum of six months between changes. A new pump or a recently overhauled pump should have the oil changed at 3 or 4 months.
2. Clean the crank case thoroughly after a year.
3. Check the oil pump suction screen if the pump is pressure-lubricated.

In conclusion we should like to point out, since we are dealing with a corrosive fluid, that specific maintenance procedures cannot be covered in a generalized paper but that most of the above will apply to West Texas floods and salt-water-disposal systems. Manufacturers are constantly trying to improve equipment to try to overcome troubles encountered, but not all of the corrosion problems can be answered by metallurgy and design. At times, it may be necessary to change the treatment of the water in order to combat corrosion of injection equipment.

Our discussion has covered only single-acting multiple-plunger-type pumps, but practically all of the principles covered apply to duplex double-acting pumps. Five minutes per day with the pump shut down for inspection and performance of preventative maintenance can pay off in better operation at a lower cost in your injection pumps.