The Care and Maintenance of Rod Pumps

By Hugh M. McNaul

Oil Well Supply Division
Odessa, Texas

The care and maintenance of rod pumps may be considered under two categories; first, proper care, maintenance, and handling of the pump during its assembly, its delivery from the pump shop to the well and its installation in the well; and second, a careful analysis of the conditions of the well being pumped and operating the surface equipment to suit those conditions. We will discuss this subject of how we can prolong the life of pumps before the pump is installed and after it is run in the well.

Very few producers assemble or repair their own pumps now. They rely on the supply company who sold the pump to assemble it properly and to check and repair it each time it is pulled from the well. Years ago the most commonly used pump was the common steel working barrel and the replacement of the cups and balls and seats required no special tools or skill. This type of pump was repaired by the crew and still is wherever it is used. The insert pump that is run on the rods and seated in the tubing string has many advantages over the tubing pump for most wells today. Some of these advantages are as follows:

1. The complete pump consisting of barrel, traveling valve and standing valve is available for inspection when the rods are pulled. It is not necessary to pull tubing to inspect or replace the barrel as it is in a tubing pump.

2. The insert pump is available with barrels of several bores or inside diameters, 1-1/16", 1-1/4", and 1-1/2" for 2" tubing. These rod pump sizes may be used also in 2-1/2" tubing but 1-3/4" and 2" bore pumps are also available in rod pumps for 2-1/2" tubing. Generally it is an advantage to use the smallest bore pump that will produce the required amount of fluid. This subject of selecting the correct bore pump will be well covered by Mr. Leichliter. So we will not spend much time on it except to say that the use of the correct size pumps, and one not larger than necessary to obtain the production, will result in a lower cost in maintaining not only the rod pump. The smaller pump lowers the rod stress. It reduces the horse power requirements of the prime mover. It reduces the torque of the gear box and the load on the pumping unit beam. In many wells it is necessary to pump large volumes of water along with the oil and a pump with much larger bore must be selected for these conditions.

Before we start our discussion of the care and skill that is required of the pump shop man that repairs and assembles the pump, we would like to mention a remark that was made by a superintendent to the writer about the importance of this job. He said he would prefer running a hundred dollar pump in a well that was assembled by a skilled and careful workman than running a five hundred dollar pump that was assembled by a careless, inexperienced workman. He said the properly assembled $100.00 pump had a good chance to pump for at least a short time while the $500.00 improperly assembled pump would probably not even pump up and would require the added expense of another pulling job. This superintendent had just had the sad experience of running a new high priced pump in a 9,000 foot well and a lower extension nipple unscrewed which made it necessary to pull both rods and tubing to remove the pump from the well.

It would be of little value to discuss the mechanics of assembling bottom hole rod pumps but it is of such importance that we should consider the requisites of a good pump shop. After carefully selecting the correct pump for a particular well, the next step to promote economy is the maintenance of that pump and it is the responsibility of the supply company that is selling the pump. A pump shop should be provided that has first a qualified man to assemble and repair the pumps, and secondly the shop needs many special tools and third, a good stock of parts must be available. Let us consider each of these separately.

Most important is the man who does the work. He should be a man who is mechanically inclined, at least slightly so. We have men who learned this job well in just a few days and others who after several weeks of pump shop work with an experienced pump man were still not yet qualified to assume the full responsibility by themselves. The shop man must look for a multitude of little things that might have caused the pump to be pulled. When he finds a part that failed he must be able to analyze the conditions that caused the failure. For example, when he finds a cage is wallowed out, a plunger is scored or washed out, a ball and seat is leaky, he must think about the causes of these failures and determine which parts he should use for replacement to prolong the time the pump will run between pulling jobs. Pump manufacturers have worked very closely with the producer in developing and designing better parts of alloy steel to combat the destructive elements in wells such as abrasion, corrosion, and excessive gassy conditions.

For example, ball and seat replacement can be decreased to a minimum with tungsten carbides. It may cost $80.00 to equip a rod pump compared to $10.00 for a set of stainless balls and seats but in corrosive or sandy fluids they often outlast the stainless many times. Saving only one pulling job would pay the extra cost of the higher cost carbide. Tubes are available that have their internal wearing surface hardened to a Rockwell C of over 60. These tubes last longer in sandy abrasive wells than do just cold drawn precision honed tubes that are unhardened. Different methods accomplish the hardening. One of the latest developments in producing tubes with hard, wear resistant internal bores is the practice of nitriding tubes. This method produces a uniform file hardness greater than that of glass on the inside wearing sufrace of the tube yet leaves the outside of the tube unhardened but tough and strong.

In liner pumps different types of liners are available. A popular one is a chrome molybdenum electric furnace iron that is centrifugally cast and hardened to withstand abrasion and wear. Another liner available is a ferrous alloy consisting principally of iron and carbon in combination with percentages of nickel and boron. This metal while in the molten state, is spun centrifugally in seamless steel tubing. This type of liner has the strength of steel but its inlaid metal in the bore has much greater hardness than the spun cast iron liner. Pump manufacturers are required to make pump parts of materials that are resistant to the corrision of specific fluids. Some of the high chrome steel parts that are so resistant to the salt water corrision of certain California, Arkansas, or Wolfcamp wells of West Texas may be a complete failure in the hydrogen sulphide wells at Penwell, McElroy or Howard Glasscock fields. Nickel-moly steels are more successful in these wells. A good pump shop man studies the parts that fail in a pump and works with his plant to obtain parts more suitable to the conditions of the wells which he services. We may be deviating here to the subject of pump selection but it is so closely connected to maintenance that we mention it.

The pump shop must be well equipped. It needs a bench with a friction vise to hold the pump tube. It needs many friction wrenches of different sizes to grip plungers, pull tubes, valve rods, extension nipples, barrel tubes and blind cages. It needs cage wrenches, good tools for the alignment of sectional liner barrels and sectional plungers. A vacuum ball and seat tester is almost a must. Inside micrometers for measuring barrel wear and outside micrometers for measuring plunger wear are needed. A good metal to metal rod pump has a clearance between barrel and plunger of from 1 to 3 thousandths. It is easy to see how using a pipe vise or pipe wrench would crimp the barrel and cause the pump to stick in the well increasing the maintenance cost to the producer.

Even transporting the pump from the shop to the well and running it into the well requires care because the pump is a piece of precision equipment. Just letting it fall a foot or allowing a hammer or wrench to drop on the pump could damage it and make it stick. We heard of one pump that was ruined by being chained with a load binder on top of a truck load of sucker rods. Some manufacturers are designing ingenious methods to lock sectional liners in place and making misalignment of liners almost impossible. On some sizes this type of construction is not possible. On liner pumps that do not have the liners locked in they should be handled with extra care. Any horizontal jar is apt to knock a liner out. This type of pump is much more rugged in the vertical position. We have seen many pumps that were bumped and pounded in the well and the liners were found to be in perfect alignment.

Up until now we have been talking about the care and maintenance of pumps in the pump shop and their delivery to the well. Let us now consider this subject from the standpoint of producing the well after the rod pump is installed. We will consider different types of wells and discuss a few methods that may result in fewer pulling jobs and longer pump runs.

First, the fluids of wells in some fields have a tendency to deposit gyps, bentonite or a corrosive scale on that part of the barrel that does not contact the plunger on the pumping stroke. These depositions adhere very tightly in many cases. This condition is found in a few wells at Crane, McCamey, some wells being water flooded near Royalty and in the Sprayberry. The pump failure often occurs when the pumper either raises or lowers the pump just a few inches by changing his clamp on the polished rod. The plunger then will contact part of the barrel where before it was not stroking. If the plunger and barrel are worn very little, the plunger may actually cut the gyp from the barrel. However, if the plunger is just a little worn, the foreign material, tightly adhering to the barrel may wedge a tight grip of barrel and plunger. The pump may then be stuck so tight the bumping or raising it will accomplish nothing, and the pump has to be pulled. One solution to this problem is the issue of a stroke through pump and the careful spacing of such a pump. In a rod pump for 2" tubing, this type of pump cannot be a 1-1/2" bore. It must be either 1-1/16" or 1-1/4" bore. It consists of a barrel, either tube or liner type, that has extension nipples of a larger inside diameter than the barrel. The lengths of the extension nipples, barrel and plunger are all designed so that on each stroke of the pump, the full surface of the plunger contacts the full surface of the barrel. The plunger strokes out of the barrel into the extension nipple a little on each end.

Such a pump is not flexible in that it cannot be made suitable to a number of different polished rod strokes. It must be tailor made to each specific job after a careful consideration of polished rod strokes, and depth. Foreign material cannot adhere to the barrel on such a stroke through pump because the barrel and plunger are wiped clean on every stroke. A plain plunger (not grooved) is best for this type of installation because the foreign material might pack in the plunger grooves and cause excessive plunger and barrel wear. A stroke through pump has no value for any well except one that has a tendency to deposit foreign materials.

Next, let us consider stripper wells that produce low volumes of fluid. We believe that more skill and care are required to operate small wells in sand laden fields that make from perhaps two to twenty barrels of fluid per day. The operation of producing these wells is soon in the "red" if frequent pulling jobs are required and surely the cost of pulling pumps should be included in the cost of the maintenance of rod pumps.

Our observation is that one cause of excessive pulling of this type of well is that the operator is not satisfied with the amount of fluid that is available and the well is overpumped. An example is a 2500' shallow well in South Ward pumping from a sand pay. This well was pumped with an 1-1/2" bore pump at 16-38" strokes per minute, twenty four hours a day. This well made no water and the maximum of 12 barrels of fluid was pumped each day. Thus the pump was continually pounding fluid near the bottom of the stroke. The well was pumped down so low that there was practically no fluid pressure against the sand pay zone. Consequently loose sand heaved into the well bore and the pump was churning this sand with very little fluid to keep it moving it through the pump. This sand was of such small grains that it is called "floating sand" and wore the bore of the pump barrel and plunger surface very rapidly. After 30 days of continuous operation, the plunger and barrel seized very tightly and the pump unseated itself. It was pulled and taken to a pump shop. In this case it was possible to remove the plunger from the barrel with a hydraulic pump. It was found after miking the barrel and plunger that the barrel was worn .008" and plunger was worn .010". Overpumping and allowing excessive sand to slough into the well bore had caused this abrasive action of the barrel and plunger, finally resulting in so much clearance that the sand wedged between barrel and plunger causing them to jam.

Either intermittent pumping or using a smaller bore pump would have increased the life of this pump. Fluid should have been against the wall of the pay zone at all times.

Now let us consider the effect of gases and vapors in the pump. There may be free gas in the fluid and in addition large volumes of gas in solution with the fluid that may be set free with a slight drop in pressure in the well. For this reason it is very difficult to pump some wells down and many wells will apparently pump off with several hundred feet of fluid in the hole because the gases occupy the entire displacement chamber of the pump, and the pressure below the plunger cannot be raised to that of the tubing pressure. This is necessary before the traveling valve can open and deliver oil to the tubing. A relatively high intake pressure at the pump standing valve is necessary for fluid to enter the pump. There are three precautions which can be taken to minimize the adverse effects of gases.

1. The compression ratio should be made as high as possible. This is accomplished by using a closed-cage type valve below the plunger with a stationary barrel pump or a valve on top of the plunger with a traveling barrel type; spacing the pump so the travelling valve and standing valve come as close to each other as possible at the lowest position of the rods without making contact. Also the longest stroke possible with the existing equipment is desirable.

2. Flow velocities and turbulence at the pump inlet should be kept at a minimum. This is accomplished by avoiding restrictions; using the largest standing valve possible and a suitable gas anchor made of the largest pipe possible.

3. If taking the above two precautions does not overcome the difficulty of the gassy well, sometimes it can be made into a good pumping well by installing a choke at the flow line. This makes the well pump against a back pressure and prevents the pressure declines in the fluid column that result in free gas out of solution.

Next in our consideration of the problem of maintenance of rod pumps, we will discuss corrosion as it concerns the pumping operation. Much more could be said under the subject of "Selection of Rod Pumps" because a wide variety of alloy irons, steels, nonferrous alloys have been used successfully to combat the corrosive conditions of various districts. Low maintenance costs of a pump for a corrosive well begins with a very careful selection of a pump that is constructed of the materials most suitable for the conditions. These suggestions might help some in increasing pump life in corrosive wells.

Do not attempt to overproduce the well. Determine the amount of fluid available either by an individual well test or a swab test and then regulate the pumping time, speed and stroke accordingly. Corrosive wells are abrasive and wear the pumps more than wells with non-corrosive fluids.

If a travelling barrel pump is used, space the well as near to bottom as possible just barely keeping the bottom of the barrel from striking the hold-down. This helps to prevent dormant fluids from settling on top of the hold down. These dormant fluids have faster corrosive actions than moving fluids and they will often pit deeply in the lower section of the pull tube sometimes causing the pull tube to leak or to break when the pump is being unseated. For the same reason it is sometimes desirable in shallow wells to use a top hold down stationary barrel pump. In this type of design the entire pump is contacted by only moving fluid while in a bottom hold-down stationary barrel rod pump, dormant fluid will settle between the exterior barrel surface and the tubing. This might result in an accelerated rate of corrosion on the outside of the barrel tube. Very frequently pumps are pulled and sent to the pump shop for repairs and after a close inspection of all the parts nothing is found that caused the pump failure. Since the cost of pulling the pump must be included in its maintenance, we have tried on several occasions to determine the reason the pump was pulled "green." Often the reason is well justified but occasionally this expense could have been avoided. Recently an 1-1/16" bore pump was installed in a very low fluid level well in North Cowden and placed on the pump late one evening. The next morning it was not pumped up so the pumper had it pulled again. If he could have waited a full day, it would have pumped up. In most cases it is not so obvious to find the reason for the pulling.

A well may be declining in its production and the operator does not know whether he is having pump trouble or if less fluid is available than before. He then pulls the pump to find out. He might then test the tubing for leaks with a hydraulic pump tester and if he finds the pump ok, he will then decide the well conditions and not the equipment are causing the decline in fluid produced. This procedure may be satisfactory in a shallow well but it could be too costly in a deeper well. We know of one operator who attempts to overcome this type of pulling by checking his well with a Dynagraph and checking the fluid level in the casing with a recording sounding device. If he finds the fluid level pumped down to the pump and the dynagraph card indicates a fluid pound, he does not pull the well. With the dynagraph it is possible to check whether the standing valve and the traveling valve are holding or leaking. Another operator we know dumps about 30 barrels of water down the casing. He then tests his wells by producing the well in a separate tank to determine if the volume of fluid increases by the amount he dumped down the casing. If it does, he figures the pump is working o.k. If it doesn't, he pulls the well to look for equipment trouble.

Some wells flow by heads but require either to be swabbed occasionally or to be pumped to remove a dead column of fluid that overcomes the bottom hole pressure. Often such a well will flow until practically all fluid in the well bore has been exhausted. It may be a day or two before it will pump up again. Enough time should be given for it to again produce before pulling the pump.

We would have liked to have brought with us for display a few new high quality rod pump parts. It would have been a much more beautiful display. We have tried to stay on our subject and there is more education to be gained by a study of the parts we have here. Some of these caused pump failures. Others contributed to a failure and some only illustrate some of the destructive elements subjected to a rod pump.

☆