Field Care and Handling of Sucker Rods

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There are, at the present time, eight sucker rod manufacturers in the United States. They all manufacture sucker rods and couplings according to the specifications set forth by the American Petroleum Institute. In view of this, any discussion of the care and handling of sucker rods and couplings would quite naturally apply to any and all makes of sucker rods and couplings, regardless of the manufacturer.

During the past few years, a great deal of educational work has been done in regard to the proper care and handling of sucker rods. The fact that a 25 ft. rod of small diameter offers a difficult handling problem has been recognized by both the producers and the manufacturers, and steps have been taken to minimize possible damage in shipping, unloading and field handling.

To insure that rods reaching the field are of high quality the following testing and inspection procedure is regularly carried out during sucker rod manufacture:

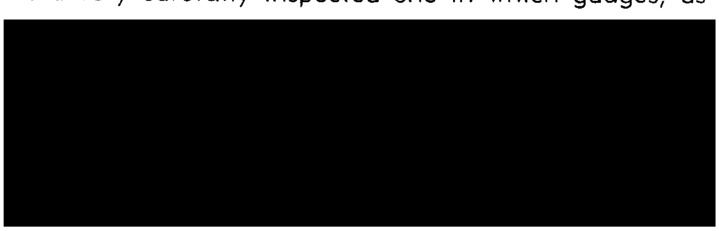
1. As rolled chemical and mechanical properties are checked after the rod stock is rolled on the bar mill and the bars are inspected for surface defects. At this point, any steel which is not considered suitable for sucker rods is rejected.

2. Straightening. The rods are run through a straightening machine to remove any bends before the manufacturing process begins.

3. Forging. This is the actual forming of the pin end of the rod. It is done by first heating the end of the bar in a furnace and then forging it to shape in an upsetter. The forged ends are carefully inspected to make sure that all portions of this part of the rod are well filled out.

4. Heat treatment. In order to obtain uniform mechanical properties throughout the length of a sucker rod it is necessary to heat treat the entire rod and it must be done in a furnace having uniform, accurately controlled temperature. The heat treating process consists of rolling the entire rod through a furnace at a controlled rate of speed and then cooling it in air. Some alloy steel rods are then reheated to a somewhat lower temperature and air cooled. This removes any internal stresses which may have been put in the rod during the straightening and upsetting operations and also produces the desired grain structure and mechanical properties. In the earlier days of sucker rod manufacture rods were heat treated only on that portion of the rod that had been subjected to the forging heat. Deeper wells and more severe operating conditions made it desirable to heat treat the rods full length. Rods are checked again for straightness after heat treatment and one rod of each diameter from each heat of steel per shift is sent to the laboratory for complete physical tests.

5. Machining. The machining and threading operation is a very carefully inspected one in which gauges, as set by the Bureau of Standards in Washington, are used to check the completed threads. The tolerance on these threads is as little as plus 0" and minus .0002". After the threads have been cut and gauged, they are greased and covered with a thread protector to keep out any dirt and avoid damage to threads.



6. Descaling. Sucker rods are descaled prior to the painting operation to improve adherence of the paint.

7. Coating. All sucker rods are coated to prevent deterioration of the steel due to the atmosphere.

8. Shipping. Sucker rods are loaded for shipment in various ways. Some manufacturers place the rods in layers separated by wooden strips and held firmly between heavy bulkheads to prevent shifting. Another method is to use a floating load consisting of individual packages of rods held together as a unit which is free to shift in the car. The railroad car is plainly marked "Do Not Hump." Humping on the railroad is the action of allowing a single car to run down an incline and run into another car in the yard shifting operation.

Manufacturing practice for couplings is also designed to produce a quality product. The usual steps for carburized, hardened and ground couplings are as follows:

1. Chemical analysis of the bar stock is a routine inspection operation to insure that materials of the proper composition will be used.
2. Coupling blanks are sawed from the bars.
3. The bars are rough ground in a centerless grinding machine.
4. The blanks are carburized in a furnace containing a high carbon atmosphere. Carbon is absorbed on the surface of the blank increasing the hardenability of the surface quite drastically.
5. The carburized blanks are centerless ground to size.
6. The blanks are drilled.
7. Wrench flats are machined on the outside.
8. In order to harden the carburized case the couplings are heated to an elevated temperature and quenched. Then they are tempered to restore a measure of ductility to the steel.
9. The couplings are then tapped.
10. They are face ground for accurate bearing against the shoulder of the sucker rod and finally they are gauged to insure compliance with API's Standard 11-B.

Much has been said about proper handling of sucker rods and transporting them to the location, in running and in pulling the strings. It is important to prevent any damage during these operations resulting from bending, nicking, or otherwise deforming the rod. One sucker rod manufacturer ships his product in unit packages of 100 rods or 2500 feet each in an effort to simplify the job of handling rods in the field. By keeping the bundles intact and handling them in this manner in the field, the danger of damage is thereby minimized.

Rather than just enumerate the things which should not be done in handling sucker rods, I should like to explain why some seemingly insignificant things can cause serious damage to the rods. We know that when a sucker rod with any reduced cross sectional area is subjected to a load, there will be a stress concentration at the exact point where the cross sectional area has been reduced. This is what takes place when corrosion eats away part of the sucker rod body. The action of the corrosive fluid has reduced the cross sectional area of the rod, resulting in a concentration of stress at this point instead of having the stress spread out evenly over the entire area of the rod. Corrosion has no relation to the handling of sucker rods, but I should like to point out that it is just as easy to have the cross sectional area of the rod reduced by hammering, dropping one rod on another, allowing the shoulder of the first rod to hit the body of the second, by having elevators dig into rod, striking the rod body with a sharp instrument such as a rig ax or many other things. In all of these cases we have reduced the cross sectional area of the rod and set up a stress concentration at that point.

Let me illustrate with an example. Take an ordinary paper clip and straighten it, then bend it back and forth and eventually it will break. On the next step take another paper clip and run an ordinary file across the clip before the bending operation. You will find that the clip will break much faster and at the exact point where the file was drawn or in other words at the point where the cross sectional area of the clip was reduced.

Any bend in the sucker rod will set up a stress concentration when a load is applied to the rod. Bends are often caused by dropping a string of rods in the well, sometimes the rods are run over by a heavy object while stored at well, sometimes they result from use of worn elevators. Worn elevators, or elevators that are canted on a well, have a tendency to bend the rod, especially when there are a number of rods hanging in the string. In this case, most of the kinks will occur 4" to 6" below the shoulder of the rod, or at the elevator base. Whenever bends do occur in a rod, the subsequent loading of the rods brings about a leverage action that in time will break the rods. I am pointing this out because the first thing anyone asks about breaks occuring in this particular part of the rod is "Did the heat treatment take care of the entire rod?" or, "is there a difference between the part of the rods subjected to the forging heat and the rest of the rod?" As we have already mentioned, all sucker rods are now fully heat treated over their entire length and laboratory tests have definitely shown that this produces a homogeneous grain structure throughout the rod.

You have all heard of the expression "corrosion fatigue." This expression has been greatly overworked as a handy explanation for any sucker rod failure. It is true that all sucker rod failures are eventually due to fatigue, but as you can see from my previous comments, not all fatigue breaks are caused by corrosion.

Perhaps the foregoing remarks would help to explain the reason for a few rules to follow in running and pulling sucker rod strings:

1. Rods should be tailed into the derrick in singles to avoid bending them unnecessarily. When rods are tailed into a derrick in doubles, there is a tendency to have a slight bend in the middle of the two rods. This causes a stress concentration point on the outside radius of the bend which is accentuated by the well load, and failure will eventually result. The tailing in operation should be no faster than the walking ability of a man on the far end of the rod, thus avoiding the process of having the pin dragged along the ground. Any rods that are kinked should be removed.

2. Thread protectors should be removed at the last possible moment. With all the care and precision exercised by the manufacturer in making the threads and protecting them, it is downright foolish to allow them to become dirty a few minutes prior to being run in a well. As we previously pointed out machining tolerances on threads are as little as plus 0" and minus .0002", and with such close tolerances, you can quite readily see how any small particles of sand or dirt would prevent proper makeup of the joint. As so often happens after sucker rods reach the well location, all of the protectors are removed before starting to run the string and sometimes the pins are allowed to be dragged in the sand. Or as may happen in most areas out here, a typical West Texas rain may splash sand in and around the pins. Unless these pins and threads are thoroughly cleaned prior to the assembly of the coupling, any dirt or sand in the threads will cause abrasive action and lead to galling which will make proper makeup extremely difficult or impossible. In addition to the above, dirt on the rod pin will also make it impossible to attain flush assembly of the pin shoulder and the coupling face. In this case there is a leverage action which will cause the pin to break in a very short time.

3. Make sure joints are made up tightly. This can easily be done if the joints are clean. This particular item is most important because we can safely say that over 99 percent of pin failures are caused by improper makeup of joints. In running high tensile rods, it may be necessary to use larger snap wrenches since it takes more force to obtain the necessary tension in the pins of this stronger steel. In the early days of running high tensile rods, numerous pin failures occurred before this fact was realized.

4. Inspect all tools such as elevators, rod hooks, wrenches, etc., regularly and repair and replace any that are worn or damaged. It has always been my contention that the price of repairing or replacing damaged parts is far less than the cost of one pulling job.

5. When running rods the bell nipple on the elevator should be level in order to prevent kinking of the rod.

6. Rod couplings should never be hammered in any manner. No doubt you have all had this pointed out to you in the past. The only reason given for hammering a coupling is that such action will loosen the coupling and allow it to be removed from the rod more easily. I wonder just how many of you know just why a coupling is easier to remove after being hammered, and this applies to tubing couplings, line pipe couplings, as well as sucker rod couplings. To demonstrate, let's go back again to my paper clip experiments. Take a clip-straighten it out and measure the length accurately. Now place the clip on an anvil and hit it with a hammer On measuring the clip the second time, you will find the length has increased. Now if we place a ring over the shoe end of the anvil and hit it with a hammer, we would find the circumference was enlarged. In the process of increasing the circumference of the coupling, we have facilitated its removal from the pin. After this explanation, I should like to point out two other very excellent reasons why couplings should never be hammered. In the first place, hammering action on a coupling sets up a stress concentration point by reducing the cross sectional area of the coupling. (Note: This is not to be confused with my expression of increasing the circumference of the coupling as just mentioned). In the second place, and to me the most important point, the couplings have a hard case of high carbon steel. A blow on this high carbon case will almost invariably cause it to crack. Once a crack has developed in the high carbon case, subsequent loading while the rod string is in service will cause these cracks to progress and eventually cause a failure of the coupling.

A point to remember from all this is that while there are various operating conditions that can cause damage to a sucker rod in the well, there is also an equally large or greater number of factors that can ruin a perfectly good sucker rod before it is run into the well.

After the rods have been run in the well, there are many operating conditions which can be controlled in order to improve the service life of rods. One of the most important factors in the life of any sucker rod string is the range load. By range load I mean the difference between maximum and minimum loads on the rods. The lower the range of load, the longer the rods are likely to stay in the well without failure. To demonstrate this I shall again go back to the paper clip. Take a paper clip and draw a file over it. Now take one end in one hand and the other end in the other hand and bend the clip back and forth slightly. The clip will break in time. Now do the same thing again, but this time bend the clip as far on one side as it will go, then reverse the operation. You will find that two or three bends are all that it takes to break the clip. In the second operation you are increasing the range of load. This is what makes it possible to eliminate failure of sucker rods that have been breaking in heavy wells simply by running them in lighter wells.

In some instances, due to the quantities of fluid which must be produced, range of load cannot be controlled, but in many cases range of load can be controlled to a certain extent by proper attention to pump size and proper combination of length of stroke and pumping speed.

Attention to pump size, particularly in stripper well production, can eliminate the danger of fluid pound. In some areas production men will say "You've got to pound them to get your production." But the fact remains that you can't take the oil out of the hole any faster than it comes in. Needless to say, a fluid pound will definitely lead to early sucker rod failures.

In corrosive areas, corrision can very often be controlled more effectively and more economically by means of chemical inhibitors than by the use of high priced sucker rods. I will not elaborate further on this subject, since correctly this should be the subject of a separate discussion.

Care should be taken in pulling stuck pumps in order to avoid stretching the sucker rod string excessively. It is obvious that such a practice will shorten the life of the sucker rods.

These are some of the more important factors in operating practices. In conclusion let me point out one thing more. The cost of A-4621 sucker rod is considerably more than either 2" or 2-1/2" tubing. Everyone is very careful to prevent crimping of tubing and damage to the tubing threads, and there is no reason why the same care should not be exercised in the handling of sucker rods.

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