Tips On Improving Sucker Rod Life

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Often, minute consuming procedures which are known to be good practice are neglected in the hope of of saving time but which actually result in hour and dollar consuming downtime. This applies particularly to handling, running, and pulling sucker rods.

This paper reviews the causes of failures and ways of preventing them, paying particular attention to causes and effects of running and pulling practices as well as making some comments on material selection. We will not cover the usual recommended practice for care and handling of sucker rods which is amply covered by API RP11BR. The discussion will be divided into four parts; rod bodies, joints, coupling selection, and corrosion.

ROD BODIES

It is well recognized that a bent rod will eventually break; however, how much of a bend can be tolerated is not so well known. New rods are straightened to no more than 1/32 in. deviation from a straight line in 5 ft. Any degree of bend imposes higher tensile stresses under load on the inside or concave side of the bend than the same load on the straight section. Therefore, if the string is operating at its maximum loading, any bend, however slight, will impose stresses above the maximum allowable and the rod will proceed to failure in fatigue. Absolute straigtness is important on heavily loaded strings.

It is well recognized that deep nicks and pits will result in rod failures. Here again, the degree of severity of the notch or pit which can be tolerated is not so well known. All rods as received from the manufacturer have a decarburized skin to a depth of .005 to .008 in. This soft skin, consisting of low carbon steel or iron, is a definite protection against corrosion and hydrogen embrittlement. A wrench tossed on a stack of rods can easily cut through or abrade this soft skin so that the base metal is exposed. Corrosion can then attck the rod at this point and generate a pit which becomes a stress raiser and will result in eventual fatigue failure. A shallow rounded depression in the surface of a rod, as it comes from the manufacturer with the decarburized skin in place, may do no harm; while a much smaller scar, no matter how smooth where the decarburized skin is broken or removed, can result in rapid corrosion and failure. Severely wire brushing a rod can shorten its life.

Rods will often rub the tubing resulting in a long lingitudinal worn place on the rod where this soft skin is removed. Corrosion pits then occur along this line. This is often incorrectly ascribed to surface defects or seams. Longitudinal seams are inherent in most hot rolled bars, but they do no harm as long as they are parallel to the lines of stress.

Paraffin scrapers can do a very good job when used with caution. However, they can seriously reduce the life of sucker rods under certain conditions.

First of all, the scrapers add weight and friction and, consequently, result in higher polished rod loads than would be normally expected with unscrapered rods. The use of standard tables in calculating maximum polished rod load should, therefore, be used with caution, together with plenty of safety factor. Where a string is designed using standard tables and formulae for maximum recommended loads, the actual loads will usually exceed both the calculated and recommended maximums.

As far as unusual stresses are concerned, scrapers produce a point of local stiffness on the rods. If the rods are bent or whipped in service, points of maximum stress, much above the average stress, then occur at points of maximum stiffness. With scrapers then, it becomes particularly important to avoid any bending action of the scrapered rods. Such bending action can occur with tight pumps on the downstroke, in pounding fluid, in crooked holes or corkscrewed tubing, and in using small rods in relatively large tubing. A case in point on this latter count would be the use of 5/8 in. rods in 2-1/2 in. tubing. Generally, it is not advisable to apply scrapers to 5/8 in. rods. If a 3/4 in., 5/8 in. taper is used and it is desired to apply scrapers to more than the amount of 3/4 in. rods required, run the 3/4 in. section to the desired scraper depth, and add 7/8 in. scrapered rods on top, if the 3/4 in. rods then become too heavily loaded.

JOINTS

In making up joints, it is essential that they be clean, well oiled, and reflect a free running fit to shoulder contact. If the coupling cannot be spun up to shoulder contact, freely by hand, corrective measures must be taken or trouble is in the offing.

It is generally recognized[1] that in a free running threaded connection 90% of the applied torque is absorbed in overcoming friction (50% at the shoulder faces and 40% in the threads) leaving only 10% of this applied torque available for generating shoulder face pressure. Any undue friction in the threads, therefore, will quickly absorb this 10% at the expense of the shoulder loading, so essential in preventing pin and coupling breakage, and leave the joint loose, in effect, for practical purposes.

Many articles[2] have been pointed out and field experience has amply demonstrated that joint make up with the proper torque is absolutely necessary on well loaded strings, if the occurrence of broken pins and couplings is to be avoided. Consistently obtaining the proper torque with snap wrenches or even power tongs is a problem. To illustrate this point; in the case of hand tools, the recommended torque for 1 in., high-tensile rods is 866 ft lb. This is equivalent to a pull of 86.6 lb at the end of a 10 ft lever arm or cheater! Attempting to obtain this tightness consistently with a 22 in. rod wrench, even a snap wrench, takes a husky man several blows with plenty of beef behind them on every joint. Also, remember, a rod crew, running a tapered string in a deep well, starts with the small rods in the morning and finishes with the large rods, requiring the highest torque, in the evening after a long hard day. Human nature being what it is, such practice particularly on heavily loaded deep strings is often disasterous. When running 1-1/8 in., 1 in., 7/8 in., and even well loaded 3/4 in. rods, power tongs are the only positive means which we have of obtaining the required torque and preventing pin and coupling failures.

Just as is the case with any other piece of mechanical equipment, however, power tongs must be kept in good order and regularly checked for power output. The writer has seen power tongs in use where gages were broken or obviously wrong and where other conditions made it difficult or impossible to check actual torque output. Pins have been stripped or pulled off by tongs which were supposedly set for the correct torque but which were putting out close to three times their indicated setting. The writer has also seen tongs whose gages indicated the correct torque, tighten joints that could almost be loosened by hand.

Using and relying on power tongs that may be in bad order can do more harm than good. They must be carefully maintained and checked; the gages should be regularly tested; and most important, the power output of the tongs should be measured on every job. One simple and inexpensive means of doing this is explained in a paper given here last year.[3]

In using hand wrenches, a cross threaded pin is easily detected and corrected. In using power tongs, a cross threaded pin may go undetected and the joint ruined. Consequently, it is excellent practice to make up one or two threads by hand before engaging the power tongs. The new deep recessed coupling is a help in stabbing joints and in preventing cross threading.

Galled threads will sometimes result from the use of improper lubricant, dirt and grit in the threads, or lack of phosphate coating on the coupling threads. Here too, this condition can go undetected if the tong operator is not alert. When galled threads do occur, maximum power is required before shoulder contact. This can be noticed by the operator and proper measures taken.

Use of a proper thread lubricant is important. Never use pipe thread dope, API pipe thread lubricant, or drill joint compound. These lubricants are designed to seal tapered threads and are too heavy for the straight sucker rod thread. One important purpose of the sucker rod thread is to generate high pressure at the shoulder faces. The lubricant should reduce thread friction to accomplish this purpose, not increase it. Light oil such as 40 grade motor oil mixed 50-50 with a good inhibitor makes an ideal sucker rod thread lubricant. Above all, do not use a pipe thread lubricant that will set up and make for hard break-out.

Hard break-out is usually caused by well fluid getting into the joint and setting up corrosion. Well fluid gets into the joint and freezes it when the coupling face or pin shoulder face is damaged, or more often when faces separate under load because of insufficient torque in original make-up. Consequently, hard break-out is not ordinarily the result of too much make-up but rather the result of too little make-up and/or the use of the wrong thread lubricant.

Hammering sucker rod couplings is known to be bad practice, particularly so with hardened and ground couplings and slim hole couplings. It will crack the case on the former and deform the latter and prevent free make-up. It is harmful to all couplings and also often to pins. A hammer blow on the pin shoulder usually deforms the seating face and thus permits fluid to enter the joint even with proper torque. However, hammering is sometimes necessary on a badly frozen joint. In this case, permit it, but throw the coupling into the mud pit and replace it with a new one. This practice will save plenty of money.

COUPLING SELECTION

For many years, the hardened and ground sucker rod coupling was considered to be the highest quality coupling. Five or six years ago, because of its susceptibility to hammering cracks, a heat treated through hardened coupling was introduced which had a thru hardness of from Rockwell C-25 to C-30. This was, supposedly, an optimum strength level and was not susceptible to cracking by hammering.

Lately hydrogen embrittlement of steel has been receiving more and more attention and is found to occur in wells where hydrogen sulphide is not evident.[4] Research work and field tests over the past two or three years have, in the past year, yielded results which indicate that a hardness level of Rockwell C-22 is a threshold value for hydrogen embrittlement. Below this value, steel is not susceptible to this phenomena; above it, its susceptibility increases. Experience now indicates that couplings below this C-22 hardness level give the best service in most cases. Of course, they will wear more quickly, but this problem can be licked by using guides or an unhardened coupling coated with a wear-resistent surface. Also where the tubing size permits, oversize couplings give excellent service.

Where slim hole or thin wall couplings are required, this thin wall is more subject to necking down and bending between the pin ends, particularly under heavy loads, than are the heavier wall couplings. The solid center coupling with its solid metal between the pin ends, which acts as a brace or strut to minimize this bending, has proved to be superior in performance to the couplings which are threaded all the way through.

The coupling threads should be phosphate coated by the manufacturer to prevent galled threads. This practice has been proved in the field by years of experience.

Coupling selection recommendations can be summarized as follows:

1. Use the unhardened standard OD coupling for general use.
2. Use the oversize unhardened coupling under heavy loading with corrosive conditions where tubing size permits.
3. Use the unhardened slim hole coupling under mildly corrosive conditions where heavy loads are not a problem.
4. Use the unhardened solid center slim hole coupling under heavy loads and/or corrosive conditions.
5. Use the thru-hardened standard OD coupling only where non-corrosive heavy loads are encountered.
6. Use the surface hardened (H&G) coupling only where excessive coupling wear is a problem.

CORROSION

Corrosion and its effects and control is beyond the scope of this paper. The use of an effective inhibitor will usually pay dividends. It is well to remember, however, that the corrosivity of well fluids not only varies from field to field, but also from well to well in the same field. It also varies with time in any one well. Therefore, the effectiveness of any inhibitor changes with time and should be checked regularly.

Waterflood operations frequently encounter microbiological corrosion, usually caused by sulphate reducing bacteria, a process not too familiar to the average producer. Ordinary inhibitors have no effect on these micro-organisms. They must be killed by using bactericides. If this type of corrosion is not recognized or if it is neglected, immense damage can result. If it is suspected, the services of a good chemical company should be secured.

Corrosion by electrolysis because of stray currents can cause severe deterioration of the rod string. An insulated union or nipple in the lead line at the stuffing box, above ground, can minimize this difficulty.

SUMMARY

Our attitude in approaching sucker rod problems has much to do with our success in handling them. When a structural steel building or bridge collapses under load, criticism is strictly confined to the person or persons responsible for the design of the structure and never to the mill that rolled the steel. This is true and justified because steel as turned out by our modern mills today is of very closely controlled quality. It is one of our most exacting engineering materials whose mechanical properties are reproducible within very close limits.

Conversely, when a string of sucker rods fails, the comment most frequently heard is that "they must have been rolled from a bad heat of steel". This is not justified nor logical since sucker rod steel is rolled under far more restrictive requirements than is ordinary structural steel. Practically all rod failures are the result of misapplication, mishandling, or are service induced. Failures due to faulty steel are so rare as to be practically non-existent.

Finally, a reasonable understanding of well conditions and rod stresses leading to good string design, a knowledge of the causes of sucker rod failures and the corrective practices required, and an up-dated selection of materials based on the most recent research developments can pay big dividends in longer sucker rod life.

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