Tension Tubing Anchors -- Reasons for Their Use

By SCOTT B. ALTER
Equipment Engineers, Inc.
Dallas, Texas

What does a string of tubing look like? When a 10,000 ft string of tubing is run into a well, all that is left to see is a few inches of tubing innocently sticking out of the wellhead, graphically portrayed in Figure 1. But, just what does the rest of the tubing look like?

what is a tubing string?

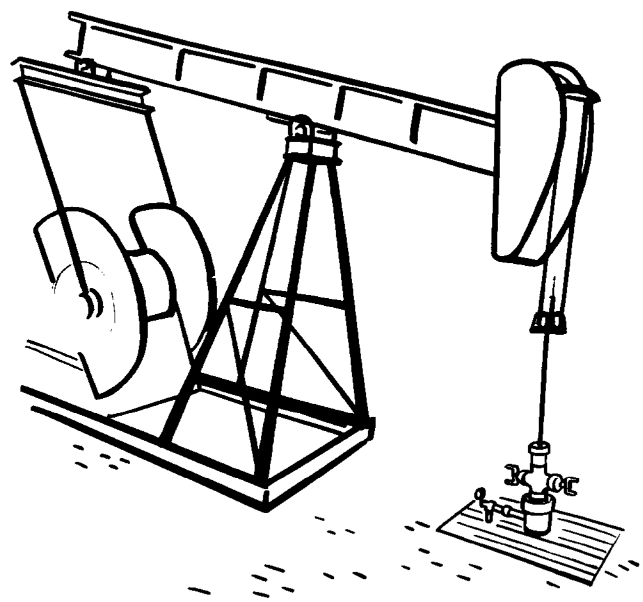

Figure 1

Now, in order to get a good look at a tubing string, we shall go to the Air Force and borrow one of its new giant cargo helicoptors and have our local supply store load 10,000 ft of tubing aboard. We shall then have the crew fly up to 10,000 ft and start running the tubing out of the plane, so that we shall have our first chance actually to see a string of tubing hanging free. All of you men work with tubing every day and unlike the local druggist, grocer, or barber, you know that the tubing manufacturer has met API specifications and that our string is perfectly safe and strong. Now, how many of you would have the nerve to stand under this 10,000 ft string hanging down from our helicoptor and look up through the tubing as the character in Figure 2 is doing?

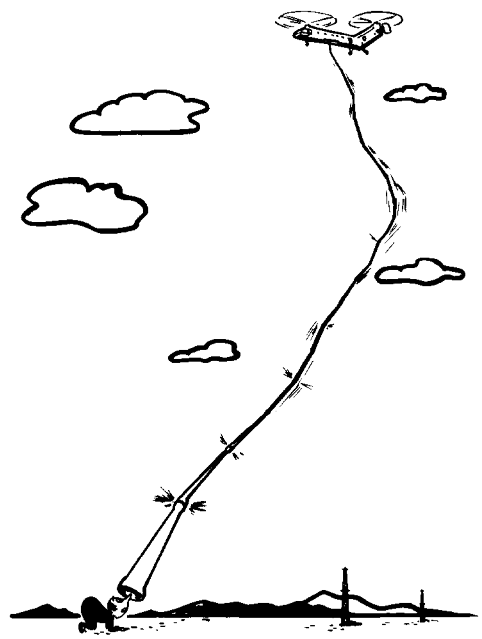

Figure 2

You should keep this fact in mind, though, that all we have is a freely hanging tubing string with no loading; so we shall put a pumping load on it. To do this we can hang a nice convertible on the end of the tubing, and then we can climb in and signal the pilot of our plane to start going up and down so that the wheels of our convertible bump on and off the ground as shown in Figure 3. This action will give us a pretty good idea of the beating that the tubing string is actually subjected to in the pumping well. How many of you are relaxed and are enjoying our ride?

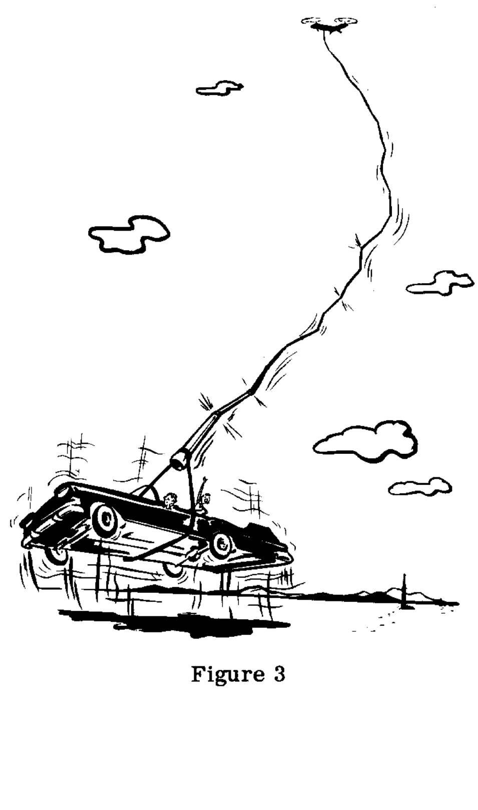

Figure 3

Many of us are not aware of our tubing problem just because we cannot see the tubing, yet the tubing is the life-line of our well. The unanchored string is actually taking a terrific abuse and this abuse, in many cases, raises our production costs greatly.

In the pumping well we have a continually varying load on the tubing because of the pump action. On the downstroke, the fluid load is on the standing valve, so that the tubing stretches out. But on the up stroke, the load is taken off the tubing by the rod string, so that the tubing shortens. Because of this varying load, we not only lose pump plunger travel and its resulting loss of efficiency but we also subject the tubing to wear and fatigue.

The reason that we lose pump efficiency is that with the unanchored string, the fluid load is dumped on the standing valve on the downstroke, thus causing the tubing to stretch out ahead of the downward-moving plunger so that the plunger does not get its full load. On the up stroke, the fluid load is removed from the standing valve and tubing and is carried by the rod string. Since the tubing is unloaded, it shortens and actually travels up with the plunger so that the relative movement of the plunger is lessened, resulting in a shortened effective plunger travel. Thus in a well 7000 ft deep, with a 60 in. polished rod stroke, the actual effective stroke at the pump may be only 48 in. or an efficiency loss due to the tubing travel of 20%. If this same well were anchored so that full plunger travel were obtained, you can see that we would get much greater pumping efficiency.

In the unanchored string, the tubing is moving up and down with every stroke of the pump, and since the tubing is always touching the casing at some spots all along its length, we shall get tubing or casing wear, which not only necessitates the pulling of the tubing to replace worn joints and collars but which can also cause the wearing of holes in the casing which are very expensive to repair.

The varying load on the tubing, caused by the placing of the fluid load first on the tubing and then by the transference of it to the rods, causes wear damage to the threads of both the tubing and the collars, which, in turn, causes collar leaks. This varying load also causes thread fatigue, which in many cases ends in a parted string. You should remember that it is not just the weight of the tubing and of its load that causes trouble, but it is the continual reversals of loading that cause fatigue to the metal and its resulting failure.

Many types of tubing anchors are available to the production man. Those of the hookwall type, or compression type, as they are sometimes called, do a partial job, but they of necessity have to be run approximately 20% of the tubing length off bottom so that the whole string is not anchored. The hydraulic types have helped in some cases but in many other cases they have not done the job required, as they may be continually moving and it is never known for sure whether they are holding. In the last two or three years several manufacturers have come out with mechanical-tension tubing anchors. By a mechanical-tension tubing anchor we mean one that can be set and a desired tension can be pulled and left on the tubing. With the tubing left in tension, the string is now as straight as the hole was drilled, and all tubing movement due to fluid load transfer has been eliminated. Since the tubing is now anchored and cannot move, the plunger travel at the bottom of the well closely approximates the travel of the polished rod so that pump efficiency is vastly increased. Also, because of the elimination of tubing travel, worn collars and wear between the tubing and the casing are a thing of the past.

The amount of tension to be pulled on the string of tubing should not be left up to a figment of the imagination but should be carefully decided upon. It is not within the scope of this paper to go into the calculation of the proper tension required under various conditions. However, the paper compiled by Arthur Lubinski and K. A. Blenkarn entitled "Buckling of Tubing in Pumping Wells - Its Effects and Means for Controlling It" is available for references. (1) In this paper the authors not only describe the benefits derived by the use of tension anchors but also present charts for the calculation of proper tension to be applied to the tubing in a pumping well.

Actually when a tension anchor is properly installed, the tubing is prestressed so that stresses set up in the tubing by the pumping action are not detrimental to the tubing. An analogous situation is that when a box and a pin in the rod string are properly torqued up, the stress set up in the box and the pin is greater than that to which they will be subjected because of the pumping action. Thus box-and-pin failures due to fatigue are all but eliminated. When the tubing string is properly run in tension, the stress set up in the tubing is greater than the fluid transfer load; thus reversals of load are not felt by the tubing and worn and cracked threads are eliminated. If we can eliminate collar and tubing wear and can prevent the threads from failing because of fatigue, the life of the tubing is almost indefinite, as long as we do not have a corrosion problem. This point of increasing the useful life of the tubing is of utmost importance when one bears in mind the increasing cost of steel. A long string, properly anchored in tension, will not have to be used in several shallower wells in its later life but will be available to be used in another deep pumper.

When should a tension anchor be used? Every manufacturer dreams of having his new piece of equipment used in every well, and it is really encouraging to say to oneself, "The records show that there are over 100,000 pumping wells in Texas, and since my tool is really needed, I had better start adding to my plant." On the other hand, it often happens that the oil company will say, "That tool costs approximately $300, and since we have 800 wells in this district, the total cost will be almost a quarter of a million dollars No, we can't afford that." We all know that the above thinking is entirely wrong and that both manufacturer and producer should go gradually into anything new. As a manufacturer of tension anchors, I can assure you that we have not built up a stock of 100,000 anchors; in fact, we built just one and put it on field test to see whether it did the job it was designed to do. But, if we had not built that first one and had not tested it, we would not now be in the tension anchor business. On the other hand, it would be a good idea for the above oil company to pick out several of those 800 wells and install a tension anchor in them and study just what benefits it can obtain.

Just what results should we look for when a tension anchor is installed? Recently a major oil company had a problem well on which it averaged 4 rod jobs per month. The company decided to install a tension tubing anchor in order to reduce the rod jobs. The tension anchor did the job desired, as the company has not had any rod jobs in the two months following the installation. On the other hand, the results obtained concerning production were even more startling. Prior to the installation, the well produced the following:

36 BOD
558 BWD
with 74% pump efficiency.

After the tension anchor was installed, the well is producing:

55 BOD
630 BWD
85.5% pump efficiency.

In this case, the results were very startling because the oil production was increased by 53%, but we all know that this well is the exception to the rule, as most wells just do not have the oil available. The important fact, though, is that the pumping efficiency was increased by 11 1/2% because the tubing had been anchored in tension. In wells like this one, undoubtedly it will pay this company to make more of these installations. On the other hand, in some wells the results obtained will not be nearly so startling, and these are the wells where very careful consideration should be given to the results of the test. In API's 1956 edition of *Petroleum Facts and Figures* I find this additional fact:

Figure 4

"If oil production was increased by just 2% of all the pumping wells in Texas, the value of this increased production would be over 40 million dollars a year." (2) This figure is presented to show that small but accumulative improvements will really pay off.

Now we shall get our feet back on the ground and talk about our individual wells on the leases on which we are working every day. Each one of us should pick out one problem well with which he is familiar and ask himself the following questions:

1. What would my tubing look like it it was hanging out of the sky?
2. How much is it moving up and down on each stroke of the pump?
3. How many collars are rubbing against the casing?
4. I wonder if any of the collars are leaking?
5. Since the tubing has been bouncing up and down, I wonder if any of the threads have started to crack?
6. What would my string look like stacked up in the bottom of the hole?
7. If I was able to increase the effective plunger stroke at the pump, how much more oil would I put in the tank?
8. How many times have I had to call out a pulling unit to work on the rods and tubing during this last year?
9. If I did have the tubing anchored in tension, would the dynamometer card look better?

Having considered your own well, you may have a better idea of what your tubing looks like and how it is acting. You may now have some basis on which to decide whether it is worth-while to put a tension tubing anchor in your well.

Assuming that you decide to anchor your tubing in tension, it is now up to you to pick out a tool which will do the job for you. If all you want to do is to anchor the string in tension, at the least possible cost, you merely have to take an old hookwall anchor or packer that you may have lying around and run it in the hole upside down, and you will really have your string anchored in tension. I realize that this is a ridiculous thought, but it has been made to impress upon you the fact that when you choose a tension-type tool it is most important that you choose a safe tool, that is, a tool that can be retrieved. Of necessity, a tension anchor, when set, must prevent the tubing from moving up the hole. In other words, when you wish to retrieve the anchor, the releasing mechanism, whatever type it is, must be able to release the slips from the casing when you desire to pull the tubing. To the best of my knowledge, nobody has ever developed a tool which has always worked as it is supposed to work when it has been run into an oil well. Because of this fact, especially in relation to a tension anchor, it is of utmost importance that a safety feature be built into the tool as a precautionary measure against the failure of the releasing mechanism to release the slips. Actually there are only three ways to operate a tool: putting tubing weight down on the tool, rotating the tubing from the surface, and pulling straight up on the tubing with the pulling unit.

Because of the limited weight of the tubing, I do not know of any manufacturer who has a safety device operated solely by the tubing weight. Several manufacturers have safety devices which are operated by rotating the tubing a multiple number of turns from the surface. Some manufacturers make use of the straight-up pulling power of the pulling unit in order to cause a part of the tool to fail at a predetermined load and thus to release the slips. When you are choosing a tension-type tool it is important that you pick one that has a safety device which will operate not only when the tool is shiny and new, but also when its condition has been changed after it has been in the bottom of an oil well for several years. Also, you should choose a tool that will not leave parts in the hole that will have to be fished or drilled out. As in the purchase of many other pieces of oil field equipment, you should never buy on price alone, as a few dollars invested in a better tool is very small in comparison to the price of a well.

When we entered the business of manufacturing tension anchors, we were a little concerned as to just how complicated the proper setting of tension anchors in the field might be. This concern was quickly forgotten, as no men are more practical and inventive than the oil field employees are. After they had once been shown how the tool operated and had been given the proper amount of tension to place on the tubing string, the running of tension tubing anchors was soon just another routine oil field operation. Now, I do not want to give you the impression that tension anchors have been run in a majority of our pumping wells, but it is a fact that several hundred are operating successfully. The use of tension anchors is growing by leaps and bounds, and the anchors are fast becoming a standard piece of equipment in our pumping wells because pumping with the tubing in tension has proved to be the best way.

The most important point that I want to put across is that the tubing string is not just several inches of tubing sticking out of the well head. But it is one of the most important parts of our pumping system, and the fact that we do not see it is no reason that we should forget about it. Since the tubing can readily move and is being subjected to repeated reverse loading, it should be anchored in tension.

REFERENCES

(1) Arthur Lubinski and K. A. Blenkarn. "Buckling of Tubing in Pumping Wells - - Its Effects and Means for Controlling It." Journal of Petroleum Technology, Transactions Section, March, 1957, p. 73.

(2) American Petroleum Institute. "Petroleum Facts and Figures," Oil and Gas Journal, March 18, 1957.