# TUBING WEAR: KEEPING THE ROD STRING IN TENSION

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## ABSTRACT

One issue with rod pumped wells is tubing failures due to rod on tubing wear. One of the main causes of this is rod buckling. The best way to mitigate buckling is to keep the rod string stretched out, or in tension as much as possible. In other words, maintain as high a minimum load to peak load ratio as you can. Weighted elements such as sinker bars or sinker rods are a very common method to achieve this, but it can be taken further. This paper investigates weight elements as well as adjusting pumping unit speed to maintain rod string tension, mitigating both tubing and rod failures due to mechanical rod on tubing wear.

## INTRODUCTION

Rod on tubing wear leading to holes in tubing is a major failure point for rod pumped wells that lead to downtime and workovers. One study conducted by an operator in India in 2018 and 2019 looked into failures on their rod pumped wells. The results of this study are shown in ***Figure 1***.

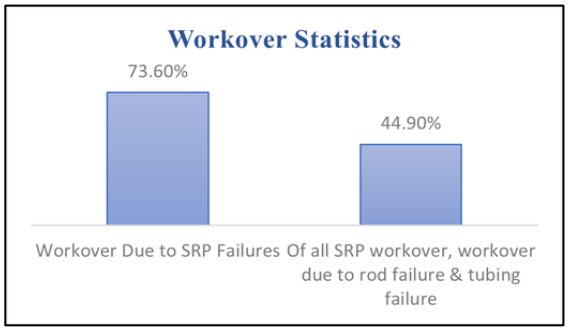


*Figure 1 - Study done on well failures on a mature field in western India*

During this time period, 73% of their workovers were done on wells with rod pump installed as the artificial lift method. Of this subset of workovers, 45% were due to tubing or rod failures (Kumar et al. 2023). The most common type of wear on tubing and rod strings occurs when the rod string is subjected to compressive forces on the downstroke (Langbauer et al. 2018). This can lead to buckling of the rod string below the neutral point as the top of the rod string is being pressed down faster than the bottom can fall as shown in ***Figure 2***. Friction created from the rods rubbing against the tubing causes wear, leading to rod parts, tubing failures, or both.

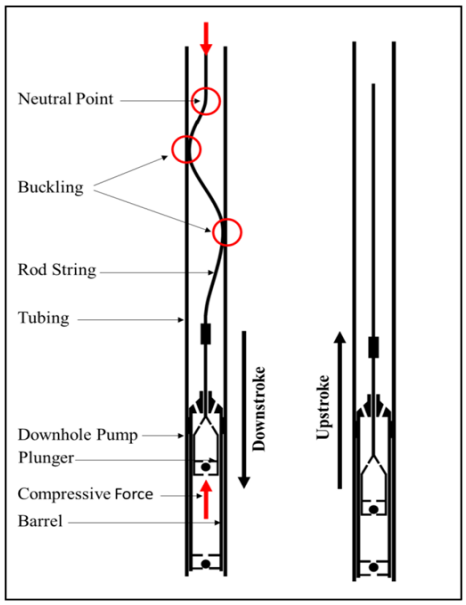


*Figure 2 - Rod buckling shown on the downstroke*

## WEIGHT COMPONENTS

A common way to mitigate this rod buckling is by using weight components at the bottom of the rod string. Both sinker bars and sinker rods are designed to be installed at the bottom of the rod string above the pump to help pull the string down and keep it in tension, lessening the buckling effect. Sinker bars are shorter and larger in diameter compared to sinker rods and sucker rods. Because of the larger diameter, they are still liable to rub against the inside of the tubing, especially through deviated sections of the well. Sinker rods are longer and thinner than bars, more akin to the normal sucker rod. Because of this, in order to achieve the same weight, sinker rods will have a much larger vertical length than an equivalent weight of sinker bars. However, because of the thinner diameter, sinker rods are able to be run with plastic rod guides. These guides act as a sort of centralizer, keeping the metal rods away from the tubing while instead allowing the much less abrasive plastic to be in contact. The plastic wears down so finely that the residue is produced with virtually no negative impact on either downhole or surface equipment. One operator in the Bakken has shown a large shift over the last 5 years away from sinker bars and towards rods in their horizontal rod pumped wells. This is illustrated in ***Table 1***. Before 2021, fewer than 20 of their wells used sinker rods and since then hundreds have been converted from sinker bars to sinker rods. The ability to be run with guides is the reason for this shift.

| An Operator in the Bakken - 2026 | | |
|---|---|---|
| Sinker Rods | Sinker Bars | Sinker Bars above KOP |
| 504 Wells | 468 Wells | 590 Wells |

*Table 1 - Weighted component breakdown of a Bakken operators rod pumped horizontal wells in 2026*

## PUMPING UNIT SPEED

Keeping weight on the bottom of the rod string is one way to maintain the life of both the tubing and rod string but there are others as well. The cyclic nature of rod pumps creates a peak load (PL) on the upstroke and a minimum load (ML) on the downstroke. The larger the difference between these two values, the quicker the rod string wears out so the higher you can get the ML/PL ratio, the longer the operating life you can get out of your rod string (Anderson et al. 1997). Simply slowing the unit down achieves this by decreasing load on the upstroke and allowing more time for the weight section to do its job pulling the rod string down in tension, increasing the load on the downstroke. This is demonstrated in ***Figure 3*** and ***Table 2*** with three dynamometer cards created in QROD showing a pump running at different speeds. These results were achieved using a conventional pumping unit with a 120-inch stroke length. The slower the speed, the higher the ML/PL ratio.

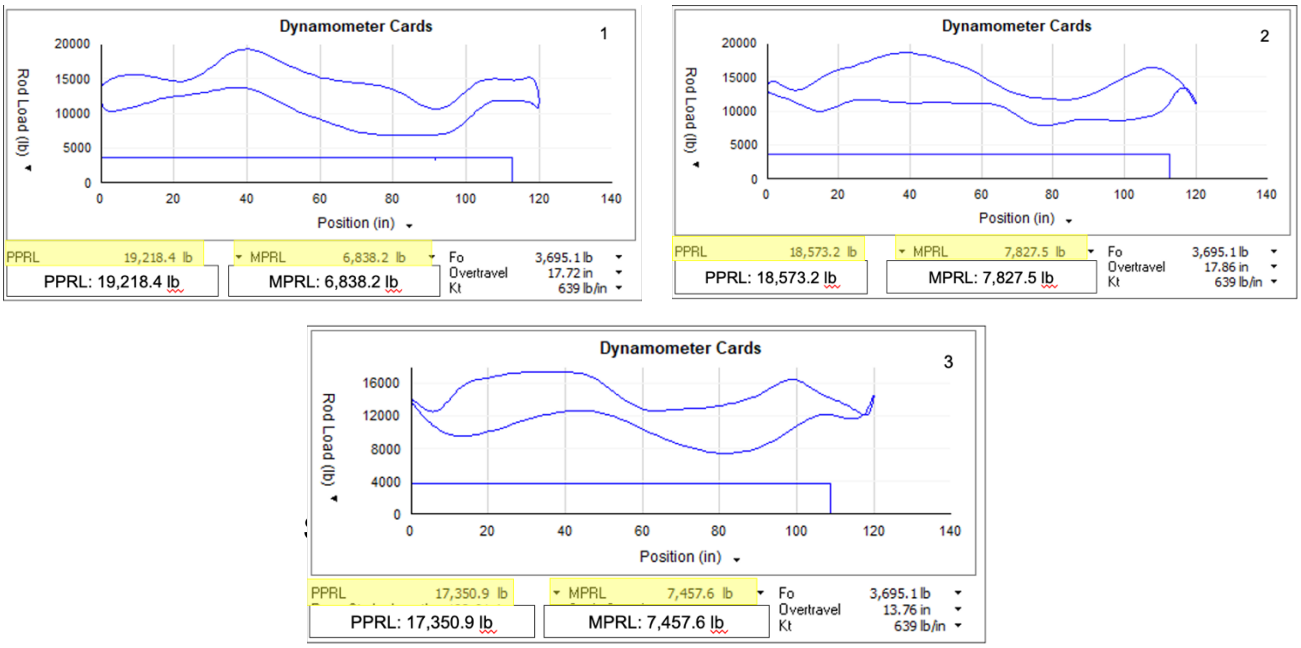


*Figure 3 - Dynamometer cards showing differing rod loads when running at different speeds*

| Dynamometer Card | SPM | PL (lbs) | ML (lbs) | ML/PL |
|---|---|---|---|---|
| 1 | 10 | 19,218.4 | 6,838.2 | 0.356 |
| 2 | 9 | 18,573.2 | 7,827.5 | 0.421 |
| 3 | 8 | 17,350.9 | 7,457.6 | 0.430 |

*Table 2 - Data from 3 dynamometer cards above*

Slowing a unit down, however, decreases production. An interesting, albeit expensive, potential solution would be to run a variable frequency drive (VFD) to be able to control the speed of the unit at all points throughout the complete stroke. To maintain a similar total strokes per minute while getting the benefit of slowing the unit down on the downstroke, the unit would need to speed up on the upstroke (thus increasing the PL as well). This would also provide the added bonus of minimizing fluid slip, or fluid slipping past the pump and falling back down on the upstroke. For the application of mitigating rod wear, a deeper look into how this increase in both ML and PL would affect the ML/PL ratio is needed.

## CONCLUSIONS

In conclusion, rod parts and tubing failures are a prevalent issue in rod pumped wells. Weight components help to maintain tension and reduce buckling in the rod string. Sinker rods may be preferable where both bars and rods are applicable due to the ability to run them with less abrasive plastic guides inside the tubing. Length constraints of the weighted section of rod string need to be considered here as well since sinker rods are longer than bars. Finally, adjusting unit speed can help to increase the ML/PL ratio and achieve a longer operating life of your rod string. The use of a VFD to control even fractions of a total stroke to attempt to decrease stress differences in the rod string without potentially giving up production volume is something to investigate further, acknowledging that the economics would need to be studied as a VFD would be expensive to run.

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