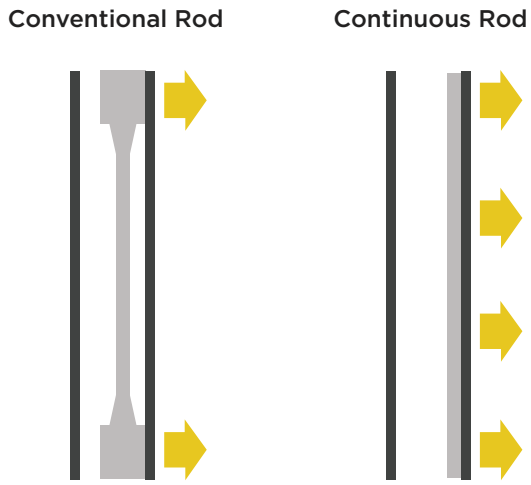
Effects of Side Loading

What is side loading?

Any given section of rod in a deviated wellbore will add some force to the tubing in that area. The amount of force is related to the dogleg severity, inclination, loading conditions of the rod and that particular section. Side load values are typically presented in pounds per 25-foot section of rod. This is the typical length of a traditional sucker rod, so it can be thought of as how much loading one rod is exerting on the tubing in that area.

Side Loading and Wear

Higher side loadings will predictably lead to quicker wear between the rod and tubing. Areas of high side loading are prone to tubing failures or coupling breaks due to the abrasive wear between the rod and tubing. When considering continuous rod, the relationship is not as simple. Wear is truly related to the PRESSURE between the rod and the tubing, not the force. When considering pressure, force per unit area, instead of simple side loading, you can see that wear can be reduced by reducing loading OR increasing contact area between the rod and tubing. The diagrams below show the difference in side loading and pressure in continuous rod and traditional stick rod.



In the figure above, the side loading would be similar for both cases. The continuous rod will have a slightly lower side loading due to a reduction in rod weight, but since side loading is measured per 25-foot section, the difference will be relatively small. However, the pressure between the rod and tubing will be very different in the two cases. For conventional rod, the entire side load will be exerted on the coupling section, which is only 4 inches per every 25 feet. The continuous rod case will have contact area between the rod and tubing for the entire length of the deviated section. Therefore, the potential length of the contact area is 75 times greater for continuous rod than conventional rod.

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EFFECTS OF SIDE LOADING

Effective Side Loading

Pressure is not a term that is commonly used to discuss rod/tubing wear in rod pumping applications. For this reason, LPS encourages the use of effective side loading when discussing continuous rod.

$$\textit{effective side loading} = \textit{side loading} \times \frac{\textit{Conventional Rod Contact Area}}{\textit{Continuous Rod Contact Area}}$$

Though continuous rod doesn't greatly reduce side loading, it does distribute the load over a greater area, reducing the effects of side loading. For this reason, a certain side loading will wear much more slowly with continuous rod than conventional rod. The side loading will effectively behave like a smaller side loading.

Contact area can be found by using the following formula:

$$\textit{contact area} = \textit{contact length} \times \textit{contact arc length}$$

If 100% of the rod is in contact with the tubing, the contact length is 25 feet for continuous rod and 4 inches for conventional rod. In reality, some sections of the rod may not be in contact for the tubing. To account for this, we will divide the continuous rod length by two, leaving 12.5 feet of contact length. The contact arc length is found by calculating the amount of the rod circumference which is contacting the tubing. For our purposes, we will assume 10% of the circumference is contacting the tubing. This value will change as the rod and tubing wears and begins to conform to each other's shape.

Since continuous rod contacts the tubing at the coupling, the diameter of the contact area is larger. 1" rod is shown in the figure above.

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EFFECTS OF SIDE LOADING

With the known dimensions of the rod and some assumptions about the percentage of rod contacting the tubing, effective side loading can be calculated for any continuous rod size.

The ratio of contact area for conventional rod and continuous rod can be given any variable. We will use Ð in this case.

Conventional vs. Continuous Rod

	7/8 CONV.	7/8 CONT.	1"CONV.	1" CONT.
Diameter (inches)	1.8125"	0.875"	2.1875"	1.0"
Contact Arc/Length	0.569"	0.275"	0.687"	0.314"
Contact Area	2.276"	41.25"	2.748"	47.10"
Contact Ratio (Ð)		0.552"		0.583"
Effective Side Load	100 lbs.	5.5 lbs.	100 lbs.	5.8 lbs.

From the above table, you can see that effective side loading with continuous rod is roughly 5-6% of the conventional rod side loading with our assumed contact percentages. Further research is needed to verify these exact values. However, it has been shown that continuous rod extends the life of rods and tubing in wells which are failing frequently due to side loading.

Effective side loading values will not be presented in traditional design software such as SROD or RODSTAR, so engineers should educate themselves on the advantages and disadvantages of continuous rod. In highly deviated wells, continuous rod can help alleviate many of the problems traditionally seen with rod pumping.

Contact us below for more information.