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DOVER ARTIFICIAL LIFT

Norris Sucker Rod and Drive Rod®

- Carbon steel vs. 4330 Special Alloy Steel

All types of steel are not created equal with regards to performance on a long term basis. There appears to be a common misconception that two rods made from different steel having the same mechanical properties (i.e. tensile and yield strength) will perform equally well in service. This is simply not the case. Mechanical strength does determine the steel's maximum, one-time load capacity; however it does not give any indication of how well the material will last when subjected to an extending period of loading. When dynamic , long-term application is intended, consideration must be made regarding how to extend the fatigue life of the material.

Rods made from special alloy 4330 steel have high levels of Nickel, Chromium, and Molybdenum. These alloying elements alter the chemical structure of the steel in a way that improves the corrosion resistance, abrasion resistance, toughness, and ductility of the material. All of these characteristics are extremely important in maximizing the service life of a rod string.

Corrosion resistance is a key factor in any rod string design. Corrosion attack degrades the rods not only by removing material resulting in less cross-sectional area, but also by producing imperfections in the rod surface which greatly accelerates fatigue damage. Any notch or divot in the surface of the rod will act as a "stress riser" which will cause stress in the immediate area to be greatly magnified. Over time, these stress risers will develop into cracks which will eventually lead to a rod failure. Nickel and Chromium are the two most effective alloying elements with regards to corrosion resistance.

Another possible source of surface imperfections or 'stress risers" in a rod string is abrasion. Rods are exposed to abrasion wear both by contact with the tubing, and by particles, such as sand, in the produced fluid. When either of these wear mechanisms attack the rod string, the result is scratching or rubbing which will have the same effect as corrosion attack. The scratched area will act as a "stress riser" and will promote accelerated fatigue damage. Again, the best prevention against this type of damage is the addition of Nickel and Chromium. These alloying elements greatly strengthen the bonds between steel grains, which makes it more difficult for wearing to remove material.

The toughness and ductility of a particular steel refers to its ability to bend rather than crack. Toughness refers to the steel's ability to withstand impact resulting from things such as power spikes in the pumping system. Ductility refers to the material's ability to bend rather than snap under high loads. Both of these characteristics are critical in determining the fatigue life of a rod string. Carbon steels typically have a low toughness and ductility. This means that once fatigue damage begins, as it inevitably will, cracking will spread very quickly. Steel containing Nickel, Chromium, and Molybdenum, has a much higher ability to flex and bend without additional cracking. This is possibly the most important quality of the 4330 steel - it will flex, bend, and deform rather than chip or crack. This has a drastic effect on the long term performance of the steel

All steel sucker rods will eventually succumb to fatigue failure. No material will last forever, however, different steels, even with the same mechanical properties, will have different fatigue life lengths. Knowing this, when selecting the best material for a specific application, one must look beyond simply the overall strength of the rod and realize that the material must, first of all stop “stress risers” from occurring, thereby not giving fatigue damage a foothold, and secondly slow the effects of the fatigue damage by having a tough ductile compression.

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