WHY INSPECT SUCKER RODS

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ABSTRACT
The purpose of this paper is not to discuss how to inspect sucker rods but why to inspect new and used sucker rods. And what has and can be found in the process.

INTRODUCTION
During the process of inspection we can detect manufacturing flaws in new rods, detect service induced flaws in used rods, detect corrosion damage, and minimize premature downhole failures by getting bad rods out of the rod string. And doing so we can reduce total production costs by keeping pulling units off your locations due to manufacturing flaws and service induced flaws in suckers.

MANUFACTURING FLAWS
A manufacturing imperfection can become a stress concentration point which can accelerate cracks and could lead to premature rod failures. No manufacturer is excluded from material or workmanship defects. Although the percentages are some time low they do exist.
Manufacturing flaw types are:
- Bar Rolling Flaws
- Forging Flaws
- Thread Rolling Flaws
- Surface Finish Flaws
- Dimensional Tolerance Noncompliance Flaws

Bar Rolling Flaws:
Lap --- A lap occurs during the rolling process: material is folded over then rolled into the surface of the rod without metallurgical bonding. (Figure 1)
Seam --- A seam is longitudinal separation in the bar stock and not metallurgical bonded. (Figure 2)

Forging Flaws:
Forging Lap ---two surfaces of metal is flash pressed into the surface during forging without metallurgical bonding. (Figure 3)
Forging Underfill --- is a depression caused by insufficient material stocking during forging. (Figure 4)

Tread Rolling Flaws:
Flank Lap --- worn rolling dies leaving a lapped pattern on the thread flanks and roots. (Figure 5)
Micro Finish --- the pin undercut and coupling contact face surface finish must not exceed 125 micro-inches. (Figure 6)
Seam in Threads --- treads are rolled over an existing seam in the forged blank.(Figure7)

Surface Finish Flaws:
Pitting --- pitting over .004” is not acceptable for new rods. (Figure 8)
Pinholes --- Pinholes in the spraymetal surface of couplings on the chamfer are rejectable. (Figure 9)

Dimensional Tolerance Noncompliance:
Dimensional Tolerance --- Undersized rod body’s. (Figure 10)

New ¾” Rod Rejection Results:

Rejection results in a six month period.
Total rejection rates is 11.71%
Body imperfections is 78%

End finish 22%

New 7/8' Rod Rejection Results:

Rejection results in a six month period
Total rejection rates is 10%
Body imperfections is 62%
End finish is 38%

New 1" Rod Rejection Results:

Rejection results in a six month period
Total rejection rate is 4.62%
Body imperfections is 66%
End finish 34%

Total rejection rate in new rods is 10.4%.
Reject results vary in each six month reporting period.

SERVICE INDUCED FLAWS IN USED RODS

Most service induced failures are either tensile or fatigue failures. A tensile failure occurs when the applied load exceeds the tensile strength of the rod. The load will concentrate at the weakest point in the string, and create a necked down appearance around the circumference of the rod, and a fracture occurs where the cross section is reduced.
A fatigue failure is progressive and begins as small stress cracks or corrosion pits that grow under stress.

Service Induced Flaws types in used rods are:
Elevator Peel
Pipe Wrench Damage
Hammer and Hatchet Damage
Loss of displacement
Tread Galling
Over Torque
Rod Wrench Damage
Rod on Tubing Wear
Over loading
Bending

Elevator Peel --- Worn or misaligned elevators can damage the upset taper of the rod, (Figure 11)

Pipe Wrench Damage --- Cuts in to the rod bodies and couplings creates stress risers. (Figure 12)

Hammer and Hatchet Damage --- Causes extensive damage to rod bodies and couplings. (Figure13)

Loss of Displacement --- Insufficient makeup or loss of displacement. (Figure 14)

Thread Galling --- Thread galling is a result of dirty or damaged threads being forced to be made-up. (Figure 15)

Over Torque --- Severely over-tightened sucker rods and couplings can be caused by hydraulic rod tongs. (Figure 16)

Rod Wrench Damage --- Can be caused by using loose or worn rod wrenches. (Figure 17)

Rod on Tubing Wear --- Contact with the tubing wall causes body, shoulder and coupling wear. (Figure 18)

Over loading --- Stress-fatigue failures occur on highly stressed sucker rods, overloads or extremely high rod loads. (Figure 19)

Bending --- bending deforms grain structure and cause wok hardening in rods. (Figure 20)

CORROSION DAMAGE

Corrosion can occur in any of the major components of sucker rod pumping systems, including the tubing, the pump and the sucker rod itself. Corrosion accounts for at least half of all sucker rod failures.

Corrosion Damage types are:
Bacteria
H2S Corrosion
CO2 Corrosion
Abrasion Corrosion
Preferential Corrosion
Acid Corrosion
Erosion Corrosion

Bacteria Corrosion --- iron oxidizing microscopic life forms tunneling around pit edges, creates possible cracking. (Figure 21)

H2S Corrosion --- has round based deep and beveled pit-edges, and is scattered over the entire rod body. (Figure 22)

CO2 Corrosion --- has steep walls, sharp edges, interconnected in long lines, the bases may be filled with iron carbonate scale. (Figure 23)

Abrasion Corrosion --- wear removes inhibitor and exposes new surface metal to corrosion. (Figure 24)

Preferential Corrosion --- hardness variations cause patterned corrosion attack. (Figure 25)

Acid Corrosion --- is sharp feather edged, no scale. (Figure 26)

Erosion Corrosion --- turbulent well fluids can erode the steel. (Figure 27)

USED ROD INSPECTION SUMMARY REPORT

Rejection causes in a six month reporting period.
Wear 18%
Corrosion 55%
Service Induced flaws 27%

Sucker rod inspection economic justifications see (Figure 28, 29)

SUMMARY

Down-hole failures have a significant impact on artificial lift costs. Sucker rods and rod couplings are subject to a host of detrimental forces and conditions. Rod inspection ensures API compliance of new and used rods and couplings. Rod inspection reduces failure frequency in new and used rod by removing problem rods from the rod string.
Reduce production costs by reducing rod failures, and keeping pulling unit off locations.

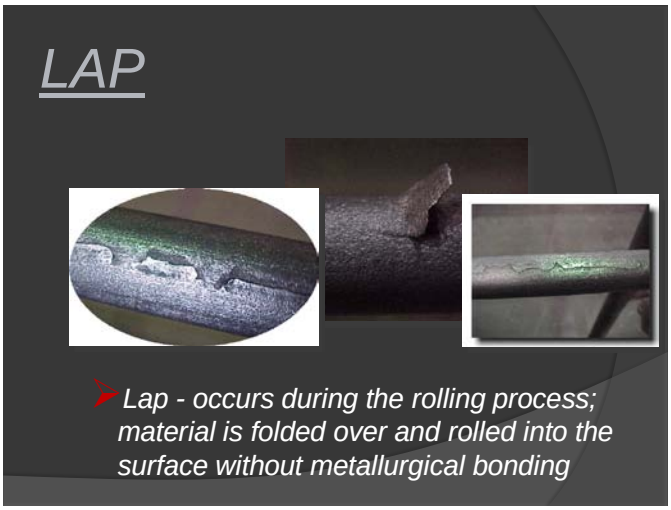
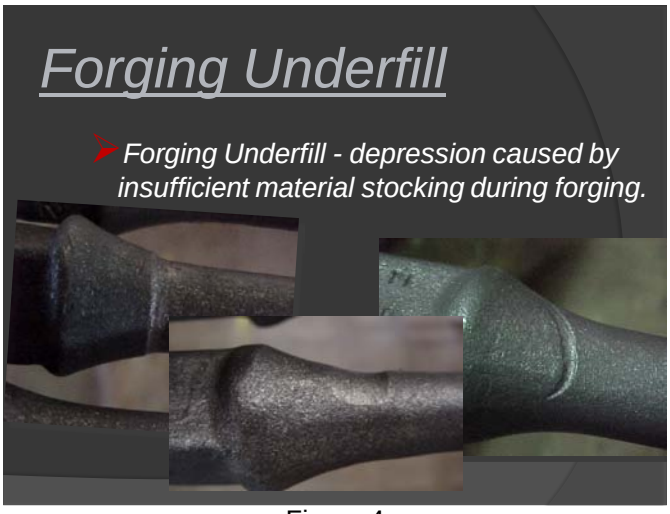


Figure 1

Figure 2

Figure 3



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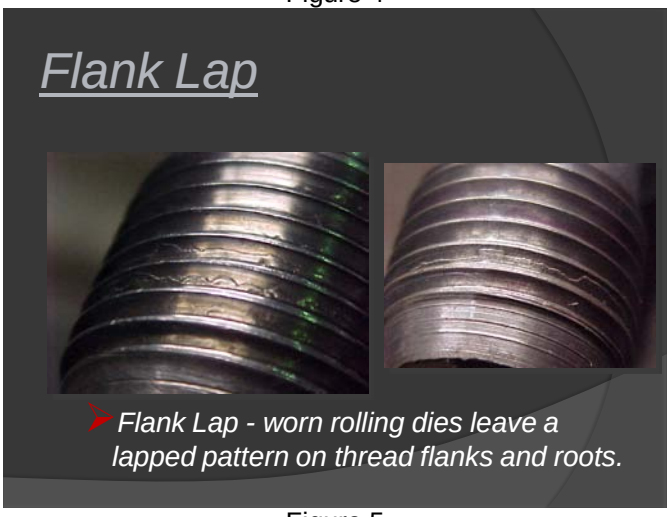


Figure 5

Figure 6

Seams in Threads

- *Seams in Threads - threads are rolled over an existing seam in the forged blank.*

Figure 7

Pitting

- *Pitting –Pitts over .004 is not acceptable for new rods.*

Figure 8

Pinholes

- *Pinhole - pinholes in the spraymetal surface on the chamfer are rejectable.*

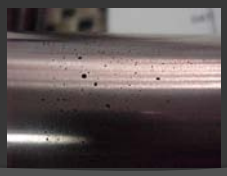


Figure 9

Figure 10

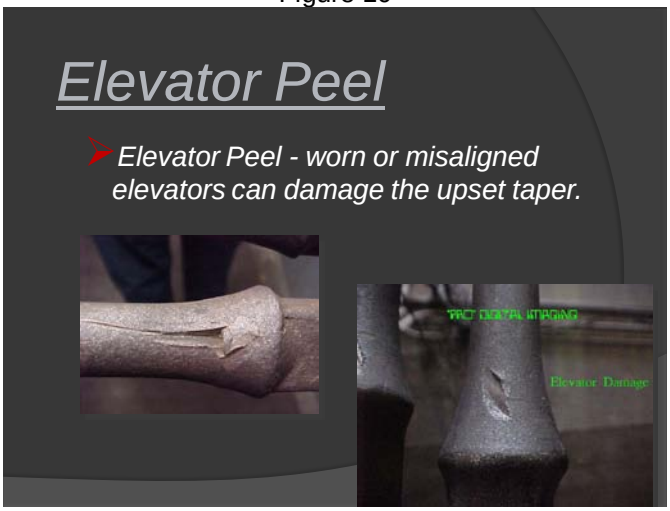


Figure 11

Figure 12

Figure 13

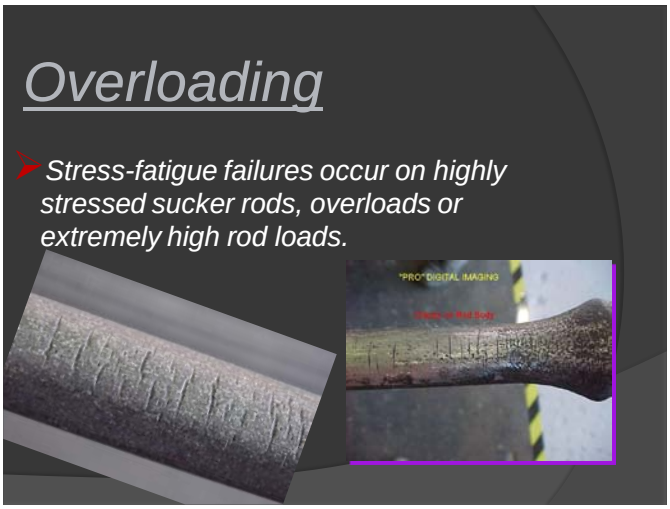
Figure 14

Figure 15

Figure 16

Figure 17

Figure 18



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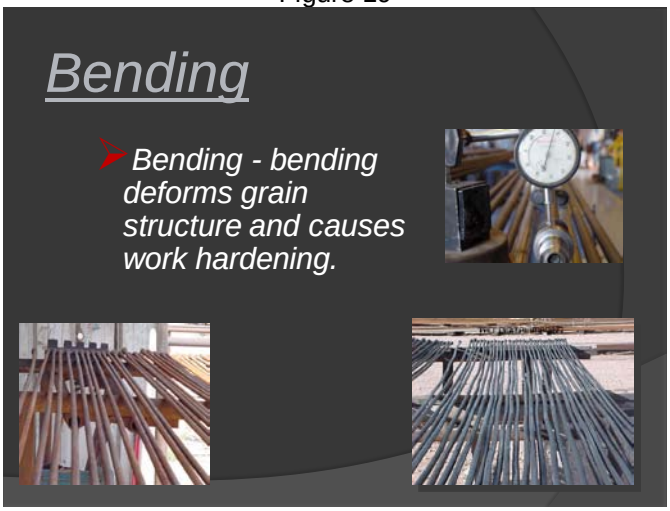


Figure 20

Figure 21

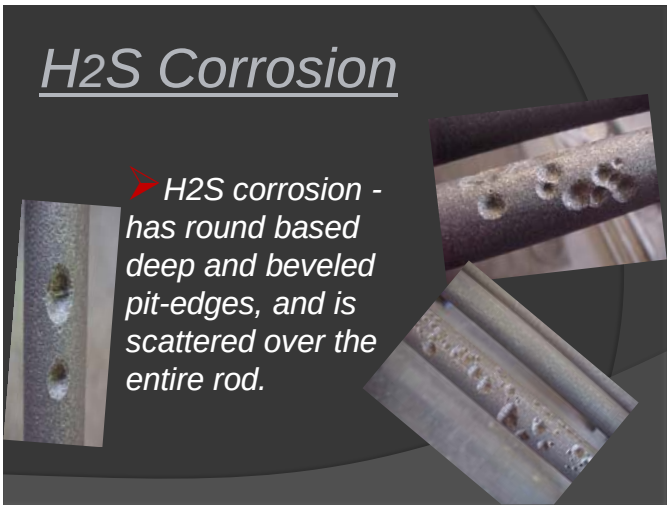


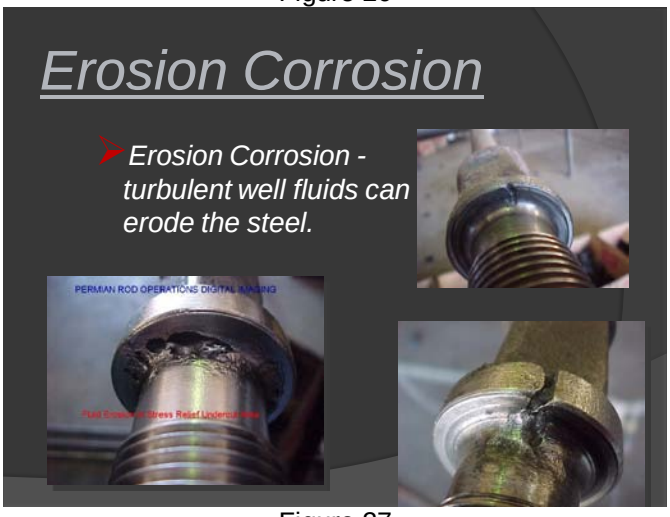
Figure 22

Figure 23

Figure 24

Figure 25

Figure 26



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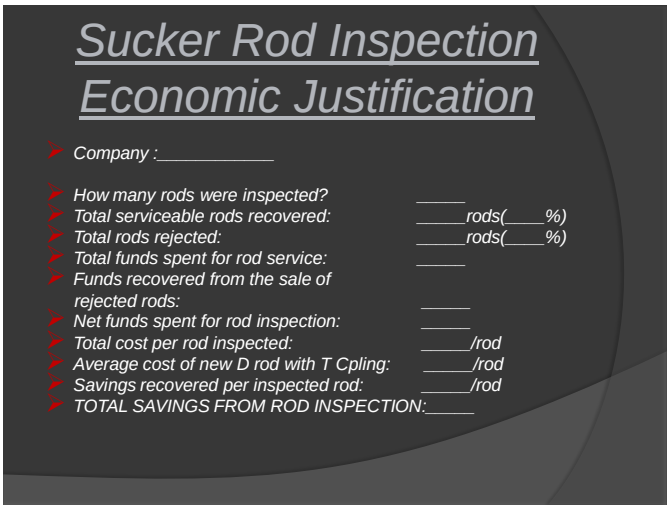

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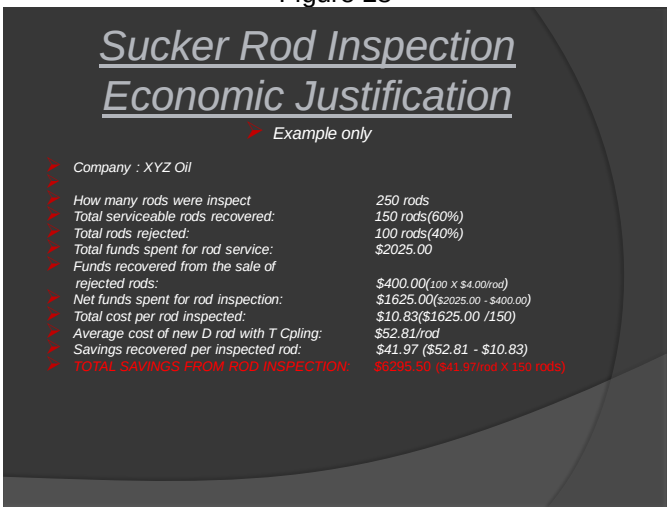

Figure 29