



# ToughMet 3 Sucker Rod Couplings

September 29, 2015

# The Problem

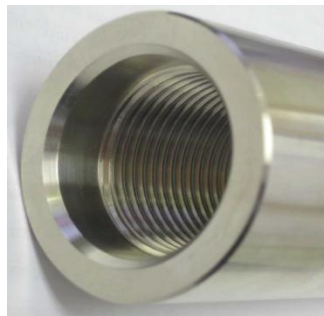
The costs of working over deviated shale wells operating on artificial lift run into the hundreds of millions of dollars per year.

Almost half of the failures in these wells is related to either tubing or sucker rod coupling failures, caused primarily by wear damage resulting from couplings contacting the inner tube wall.



# The Project

Materion and Hess Corporation collaborated to develop and field test a new coupling manufactured from ToughMet<sup>®</sup> 3, Materion's high performance, spinodal copper-nickel-tin alloy.



# The Project

- **Identify and quantify the problem**
- **Develop a new base material for sucker-rod couplings**
- Develop coupling fabrication process
- Produce prototypes using production scale process
- Investigate torque/turn behavior relative to existing technology
- Make modifications to coupling surfaces interfacing with rod
- Validate modifications via additional torque/turn studies
- Select candidate wells
- Install ToughMet<sup>®</sup> couplings during workovers
- **Evaluate performance at 6 months running**
- **Evaluate performance at 17 months running**

## Results

Results indicate the ToughMet 3 Sucker Rod Couplings mitigate one of the most common causes of tubing failure thereby reducing workover costs by \$100,000 per well per year.

The benefit of one year's uninterrupted production from a well producing 100 barrels of oil per day at \$40 per barrel is **\$150,000 to 220,000 of pre-tax cash flow** depending on how long the well is typically down for a tubing failure workover.

**The return on investment is high and the payback is quick.**

# ToughMet® 3

## Heat-treatable UNS C72900 Copper-nickel-tin Alloy

High-strength, non-galling oilfield material with more than 20 years' successful use in directional drilling tools and other oilfield equipment components.

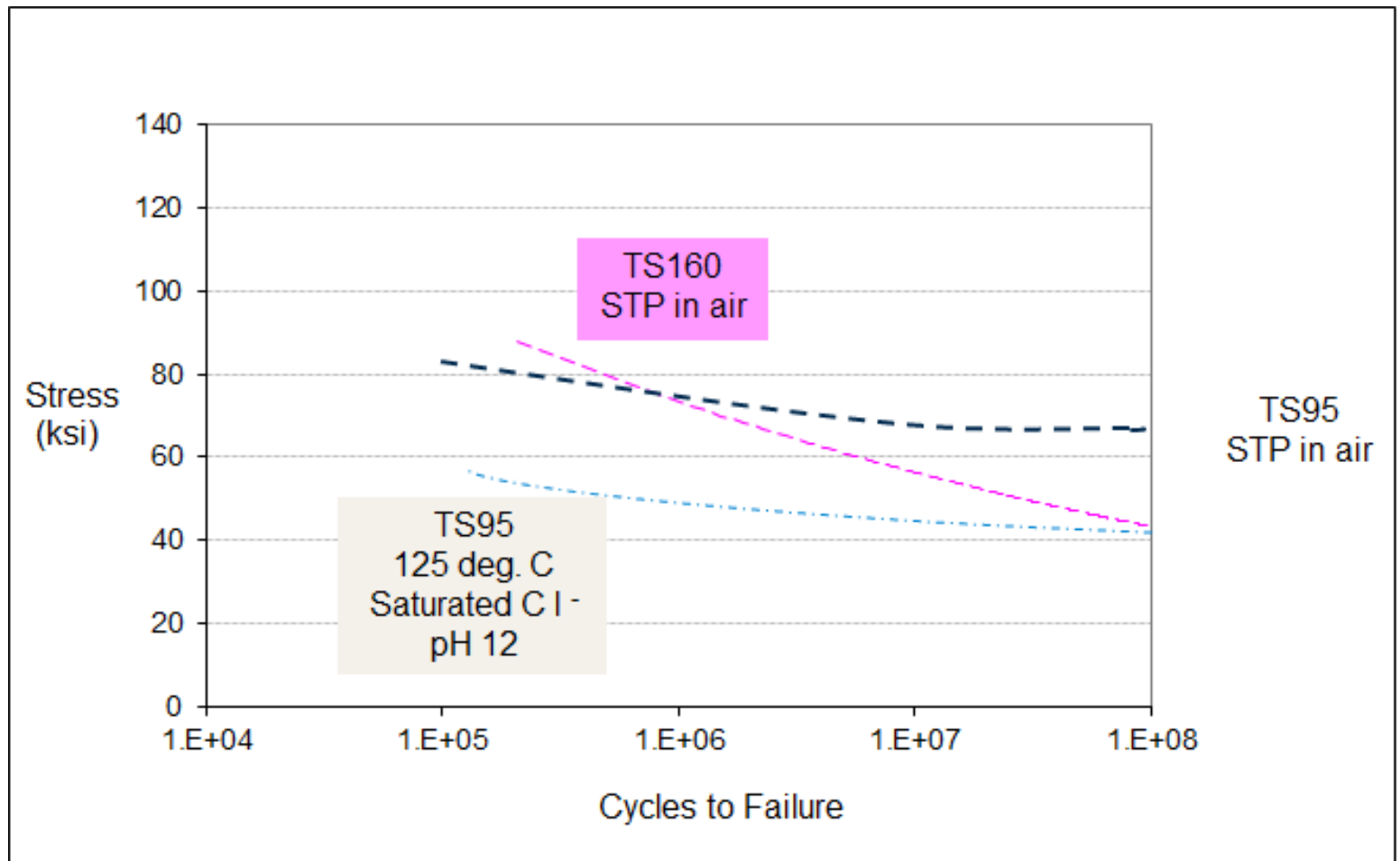


# ToughMet® 3 TS 95 Material

Property upgrades to provide ideal material for couplings

- Increased fatigue strength
- Increased fracture toughness
  
- > 95 ksi tensile yield strength
- > 65 ksi fatigue limit
- > 30 ft-lb Charpy Impact Energy
- Resistant to chloride SCC, pitting and crevice corrosion
- Resistant to erosion, HE, SSC and general corrosion (including in mildly sour wells)
- Anti-galling to typical steel production tubing and sucker rods

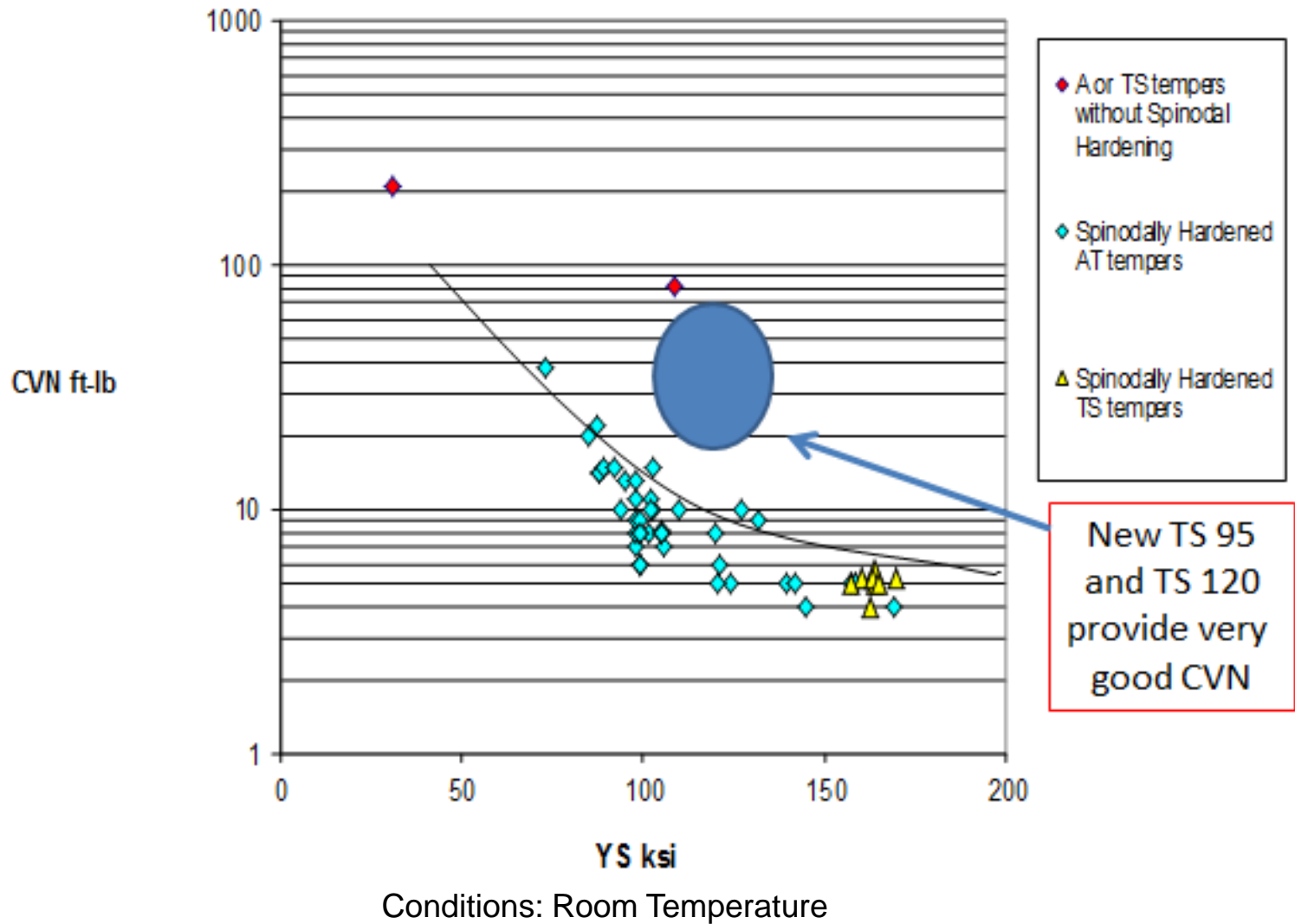
# Fatigue Strength – ToughMet® TS Tempers



Conditions: Rotating Beam Fatigue, R = -1.0



# Impact Toughness - ToughMet® 3 CVN



# Field Trials

- 11 deviated wells running in Bakken shale locations
- Typically 10,000 ft vertical /10,000 ft horizontal
- Sweet; range of water cut, sand, brine
- Typically 6 pump strokes per minute
- L80 production tubing
- Wells have history of elevated, frequent failure rates for target cause
- 1 inch slim hole couplings installed in deviated sections both near-surface and deep
- No failures in 17 months of continuous running
- 100% of inspected couplings suitable for placement back into service
- Wells continuing to run



# TOUGHMET 3

## ToughMet® 3 Sucker Rod Couplings

Eliminate frequent workovers, lower production costs and improve margin.

ToughMet 3 Sucker Rod Couplings are the most cost effective solution for eliminating production interruptions caused by sucker rod coupling and production tubing failures.

ToughMet 3 is a unique, spinodally hardened, copper-nickel-tin alloy engineered for use in the oilfield. The couplings are made of a unique temper, ToughMet 3 TS 95, the strongest and most fatigue resistant coupling material available.

ToughMet 3 Sucker Rod Couplings resist mechanical wear, thread damage, corrosion and erosion. In addition, they are non galling, so they prevent tubing and coupling damage caused by coupling and tubing contact in deviated wells.

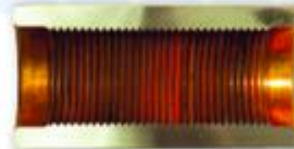
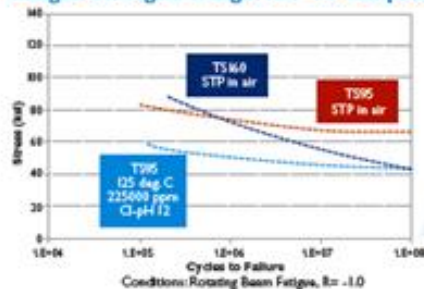
### ToughMet 3 TS 95 properties:

- High strength – Yield Strength > 95 ksi
- Fatigue Strength – > 65 ksi
- High Toughness, CVN > 30 ft-lbs
- Non Galling, Dry Coefficient of Friction < 0.3
- No Chloride SCC or Pitting
- No Sulphide SSC within established NACE limits
- Dimensions for ToughMet 3 Sucker Rod Couplings and Cross Over Sub-couplings conform to API Specification 11B



Dimensions for ToughMet 3 Sucker Rod Couplings and Cross-over Sub—Couplings conform to API 11B

### Fatigue Strength –ToughMet® TS Tempers



ToughMet 3 sucker rod coupling after 6 months of service in sucker rod string

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 Hayfield Heights, OH 44134 USA  
 p +1 216.496.6280  
 materion.com/couplings



# ToughMet<sup>®</sup> 3 Sucker Rod Coupling after 6 Months in the Well

**No evidence of wear or metal transfer**



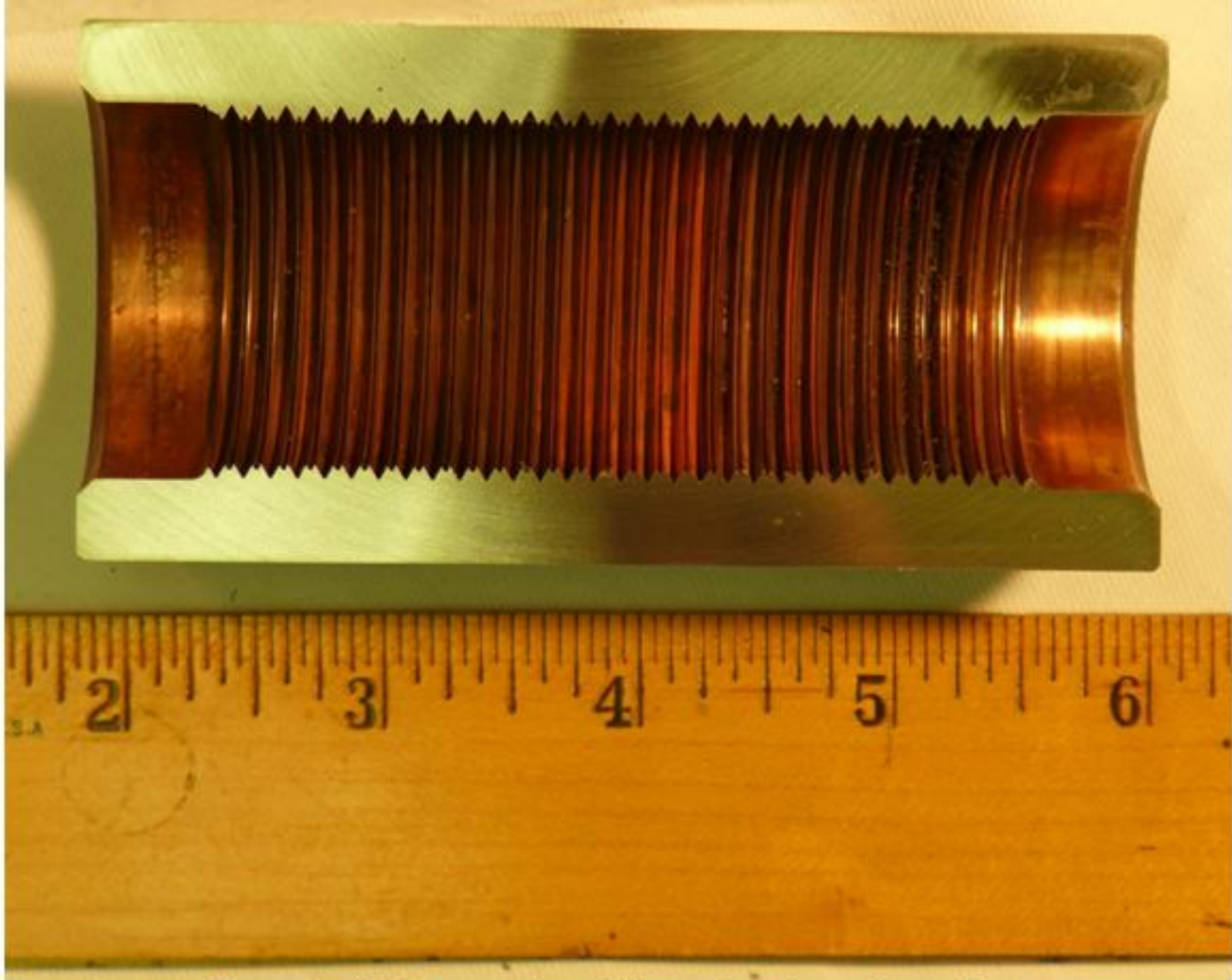


Figure 2. the Cross section of the used sucker rod coupling.



# ToughMet<sup>®</sup> 3 Sucker Rod Couplings after 17 Months in the Well

**No evidence of wear or metal transfer.  
Evidence of contact between coupling & tubing**

