Case Study of Drillpipe Tool Joint Protection

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AADE AMERICAN ASSOCIATION of DRILLING ENGINEERS
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- Do you know what type of hardbanding is on your Drillpipe, Drill Collars and Heavy Weight Drillpipe?
- Do you trip to shuffle your Drillpipe/Drill Collar & Heavy Weight Pipe to prevent excessive wear, ovality and hardband replacement costs?
- Have you looked at your charge back for Drillpipe replacement, Hardbanding repairs and reapplication?

INTRODUCTION

- Hardbanding is the process of depositing hardfacing alloys on drill pipes, collars etc. to protect both casing and drill string components from abrasive wear.

- Abrasive wear is associated with rotational, axial and side loads generated while drilling.

- Excessive side loads and wear increase in complex trajectories and highly deviated wellbores drilling across abrasive formations.

INTRODUCTION

- Advanced hardband alloys are required to provide:
  - low casing wear percentage
  - resistance to mechanical wear and corrosion
  - low coefficient of friction
  - stability at high temperatures
- Wire and powder alloys are the two common types of hardband products in the drilling industry

INTRODUCTION

Wire Alloys

- Iron-based
- MIG or GMAW welding process

Powder Alloys

- Tungsten carbide (WC) particles and nickel- or cobalt-based
- PTA welding process

INTRODUCTION

Wire Alloys

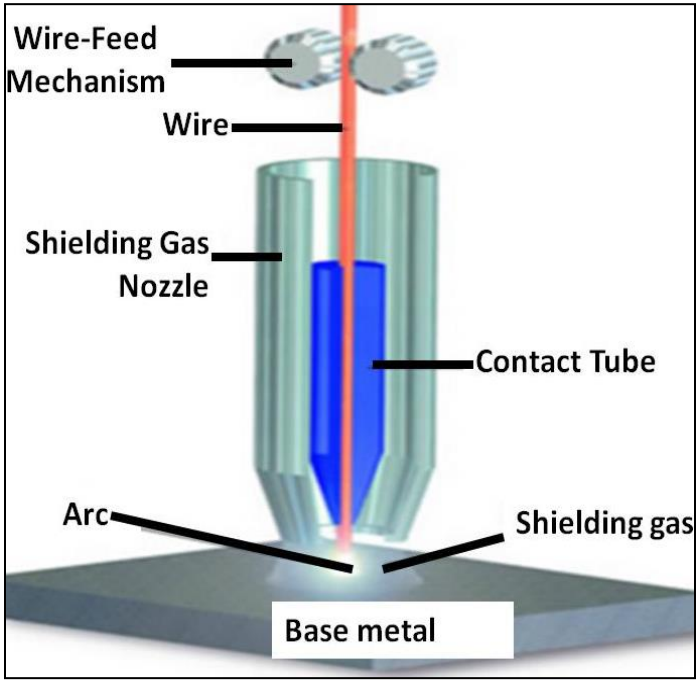
- Hard, but tough tool steel matrix
- Higher dilution into base metal
- Post weld hardness: 57- 62 HRc

Powder Alloys

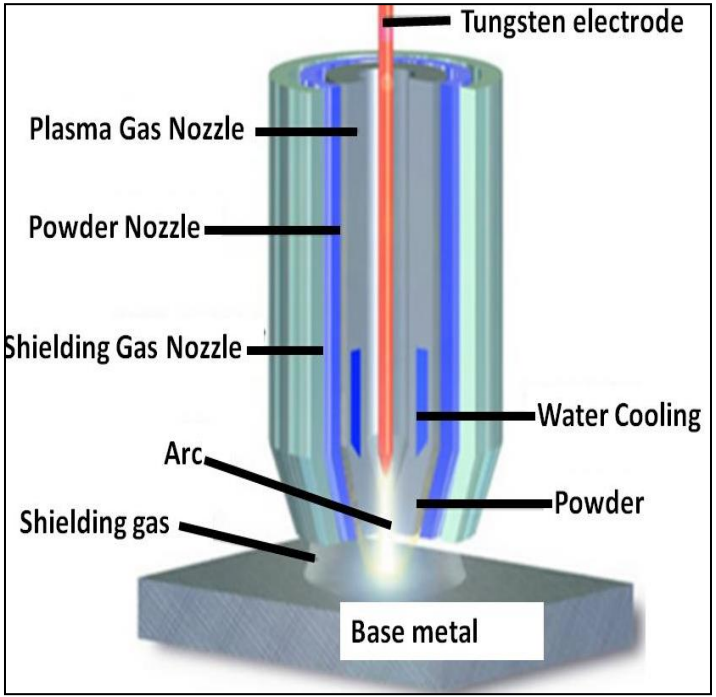
- Spherical macrocrystalline tungsten carbide (WC) particles with nickel binders
- Fine WC ~ hard matrix
- Coarse WC ~ wear resistance.
- Lower dilution into base metal
- Post weld hardness: 40 - 55 HRc

WELDING PROCESSES

Metal Inert Gas (MIG)



Plasma Transfer Arc (PTA)



WELDING PROCESSES

Metal Inert Gas (MIG)

- Preheat temp. ~ 300^{O}F - 600^{O}F
- Preheat temp. depends on experience, pipe thickness and wire type
- Interpass temp. ~ 850^{O}F

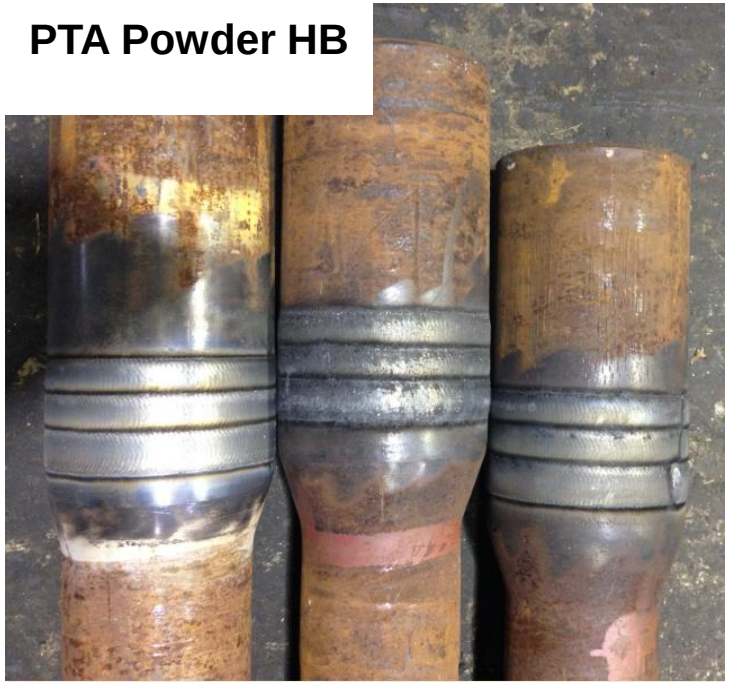
Plasma Transfer Arc (PTA)

- Preheat temp. ~ 450^{O}F - 500^{O}F
- Interpass temp. ~ 700^{O}F
- High degree of automation and reproducibility
- Low & highly concentrated heat source

OPERATIONAL BENEFITS OF PTA POWDER HARDBANDING

- PTA powder dilution~ 6-10% vs. MIG wire~ 15-25%
  - Dilution is the amount of the base metal used to form hardband weld
- Ease of automation, high degree of reproducibility and control of weld quality using optimized parameters
  - Powder feed rate
  - Gas flow rate (shield gas, plasma gas, carrier gas etc.)
  - Weld current,
  - Nozzle to work piece (base metal) distance
  - Welding speed.

OPERATIONAL BENEFITS OF PTA POWDER HARDBANDING



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OPERATIONAL BENEFITS OF PTA POWDER HARDBANDING

- PTA yields constricted and columnar welding arc, creating a highly localized heat input.
- Full fusion of the overlay material, while introducing minimum heat into the part
- Heat-affected zone (HAZ) is relatively reduced and controlled heat input ensures weld dilution is minimum.
- PTA hardbands are tougher and more corrosion resistant than hardbands overlaid by MIG process.

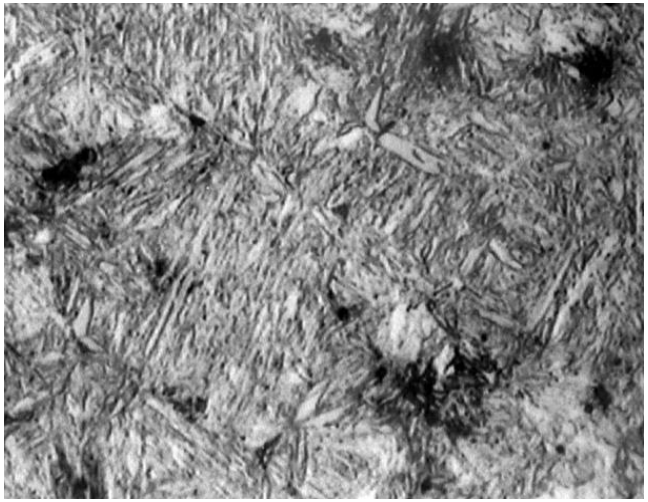
EFFECT OF HARDBANDING ON DRILLING TUBULARS

- Low-alloy steel~ AISI 4137M (tool joint); AISI 4145 (collars)
- Hardbanding should cause little or no alteration to the properties and microstructure of the low-alloy steel.
- Heat transfer during pre-heating and post-weld are crucial.
- Excessive preheat ~ High dilution of base metal in weld
- Fast cooling or low preheat ~ brittle heat affected zone (HAZ) below the weld

EFFECT OF HARDBANDING ON DRILLING TUBULARS

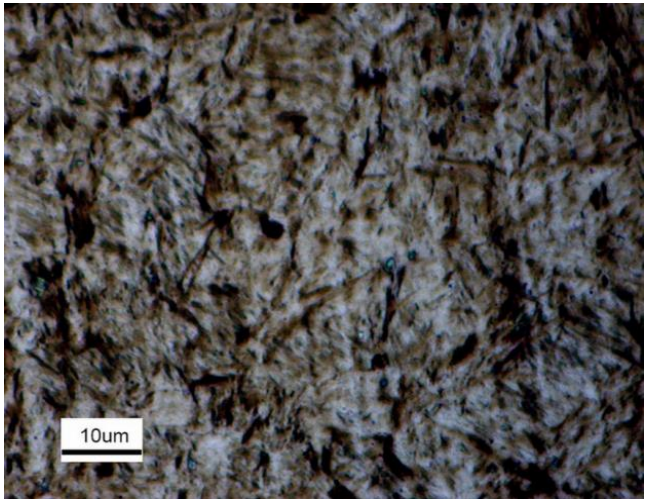
- Hardbanding (welding) process produces:
  - Expansion and contraction (thermal stresses etc.)
  - Metallurgical changes (grain growth etc.)
  - Compositional changes (diffusion effects etc.)
  - Defects: cracks, porosity, and inclusions in the base metal & HAZ
- Post weld microstructure of steel ~ cooling rate from the peak temperature (maximum interpass temperature).
- Austenitic or Martensitic microstructure

EFFECT OF HARDBANDING ON DRILLING TUBULARS



Austenitic

Fine grains, ductile



Martensitic

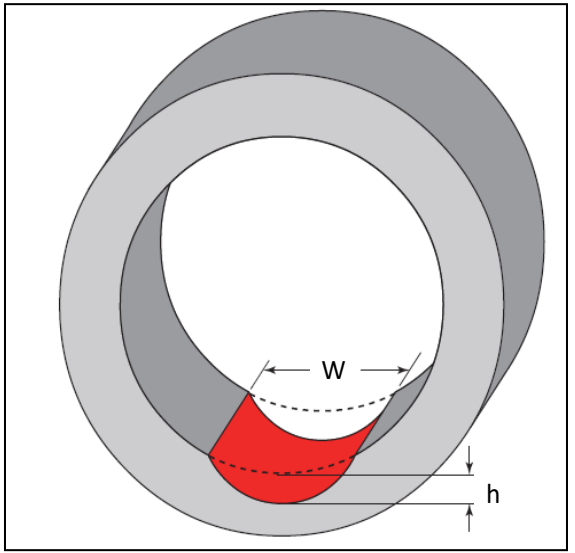
Coarse grains, brittle & hard

QUALIFICATION TESTS

- To perform 3 tests with 2 PTA powder hardbanded test specimens as described in American Petroleum Institute (API) Standard 7CW, First Edition, June 2015 entitled **“Casing Wear Tests”.**

A

B



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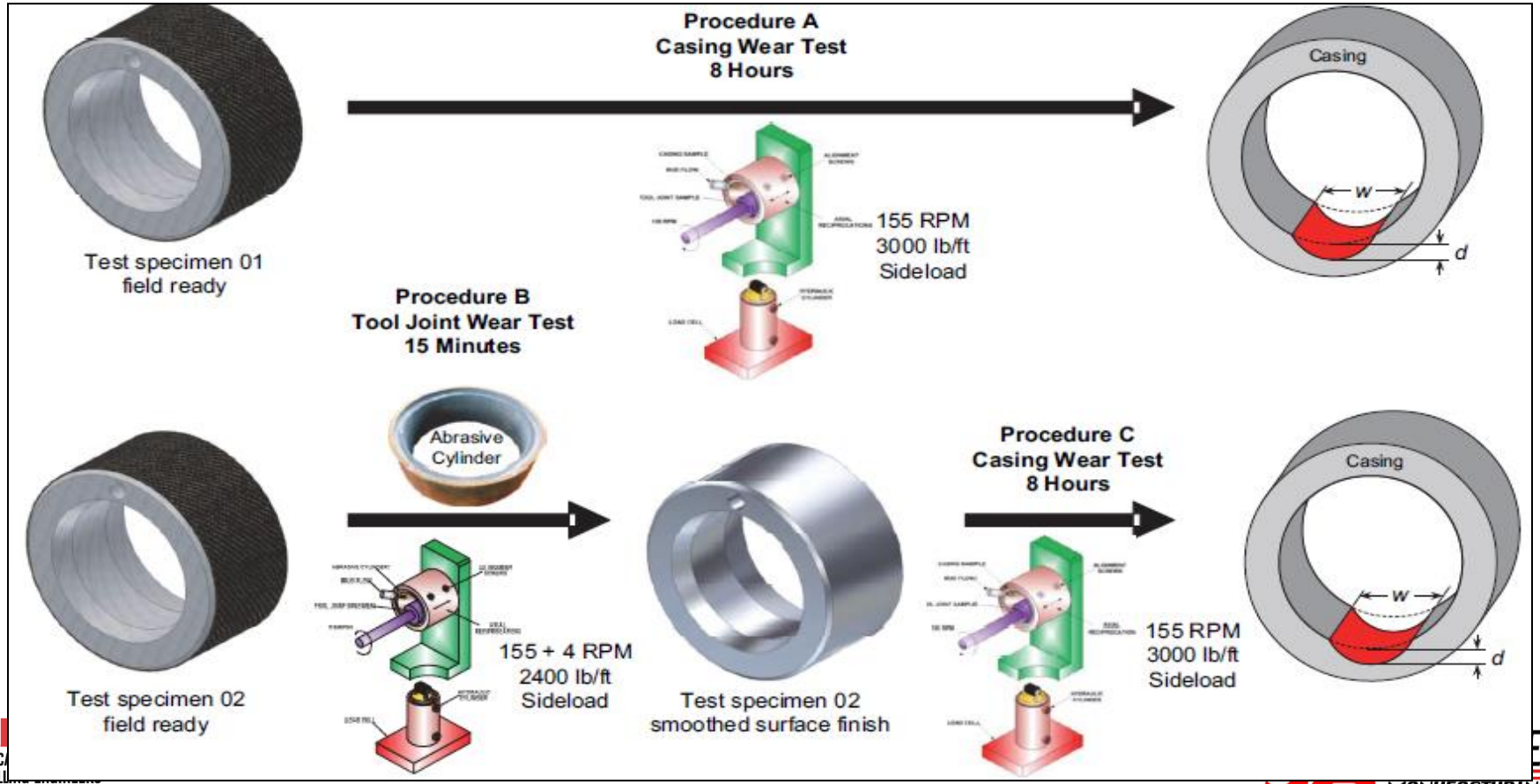
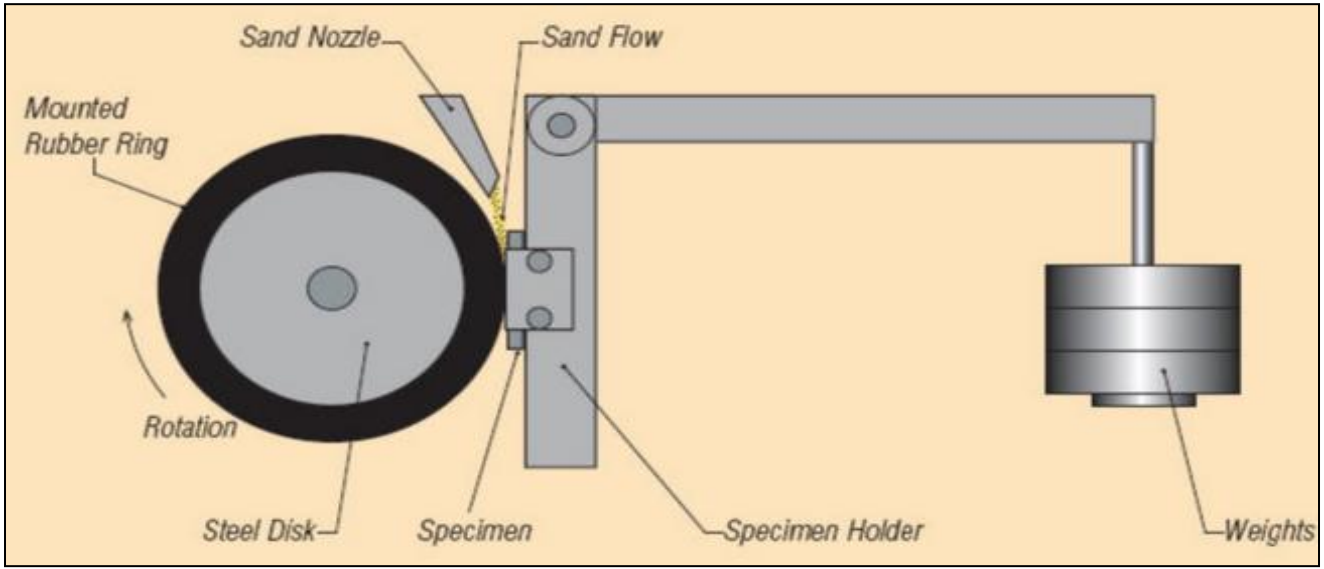
QUALIFICATION TESTS



QUALIFICATION TESTS

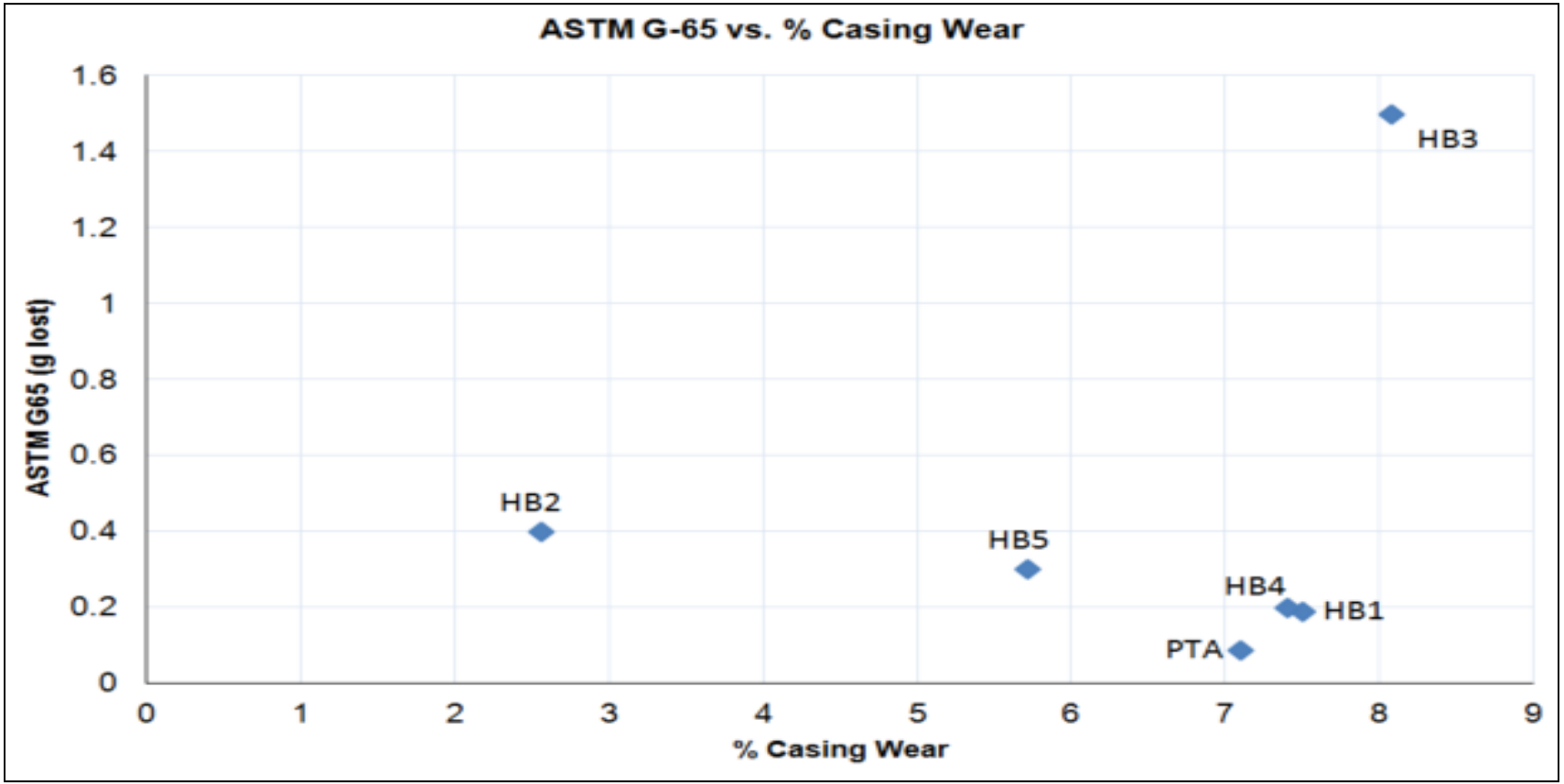
- ASTM G-65 test was conducted to determine the resistance of metallic materials to scratching abrasion by means of the dry sand/rubber wheel test.

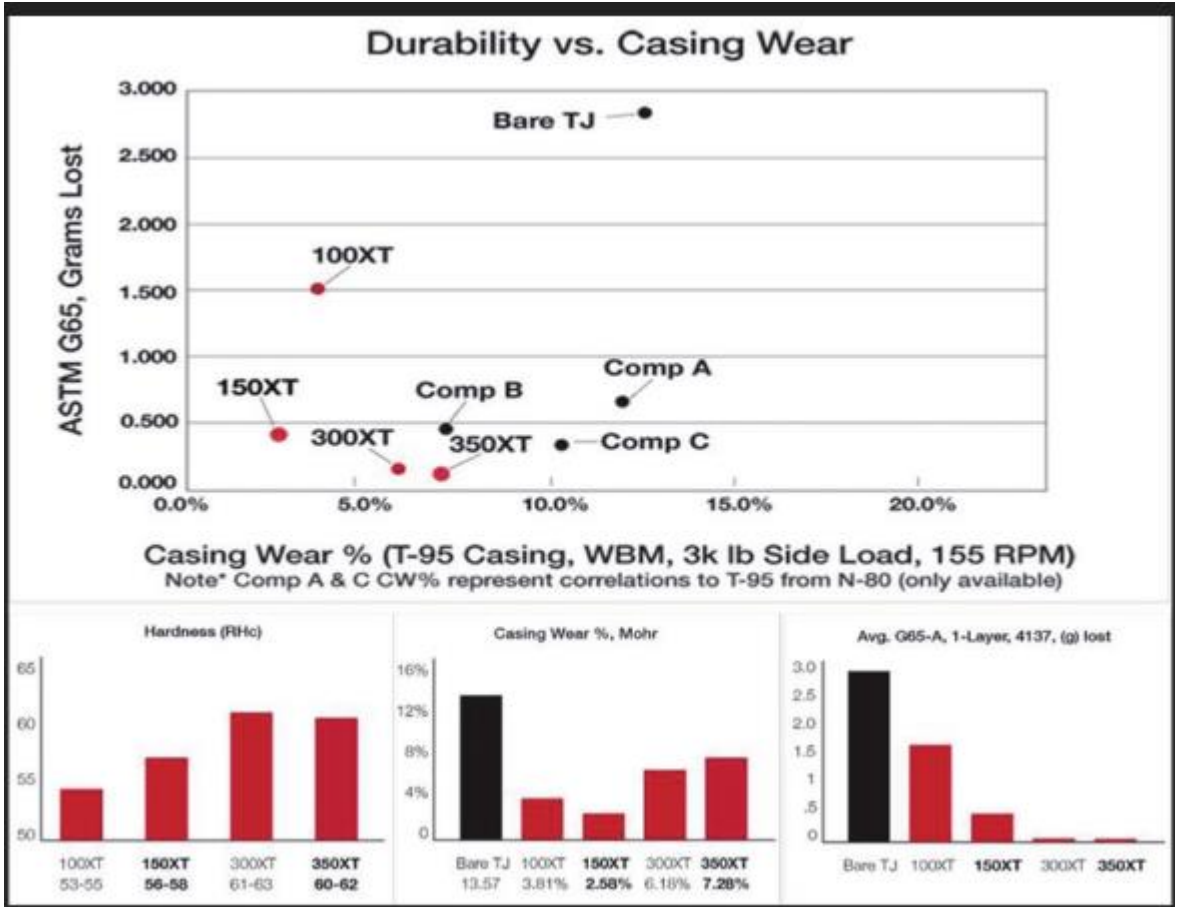


QUALIFICATION TESTS

	Products		
	PTA	Product A	Product B
Casing Wear %	7.22	7.28	7.33
Casing Wear / Hall Wear Factor (psi^{-1})	1.33	-	1.39
Tool Joint Wear in Casing (in.)	0.0113	-	-
Tool Joint Wear in Open Hole (in.)	0.04	-	0.0497
Contact Pressure Threshold (psi)	65	-	-
Revs to 87.5% Casing Wall	273,000	-	-
Hardness (HRc)	38-41	60-62	59-64
ASTM G65-A, mass lost (g)	0.086	0.16-0.21	0.279

ASTM G-65 Test Results/Casing Wear





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FIELD APPLICATION

- Independent operator in the Permian Basin, New Mexico
  - Study on the application and performance of several popular wire hardbands vs. PTA powder hardband.
  - 5" drill pipes used to drill the curve section in several wells.
  - 5 different wire hardbands and PTA powder hardband on 9 joints
  - 2nd Bone Spring and Leonard formations
  - 40,500 ft (25,369 ft in 2nd Bone Spring and 15,140 ft in Leonard)

- Independent operator in Anadarko Basin, Oklahoma
  - 4” drillpipe planned for drilling to ~20,000 ft TD/9,500 ft. lateral
  - Applied PTA hardbanding on all drillpipe
  - Utilized drillpipe in 6 well campaign without requirement to reapply
  - Achieved up to 35% cost savings and reduced cycle time to hardband drillpipe

CONCLUSION

- Drilling in Deviated, Extended laterals and ERD, and across abrasive formations requires utilization in hardband alloys with superior wear and corrosion resistance.
- PTA welding process + Powder Alloy = Operational benefits
- PTA hardbanded pipes will last avg. 7 wells when compared to the wire hardbands which typically last for 2 wells before reapplication.
- PTA powder hardbanding provided over 20% in cost savings

THANK YOU
&
QUESTIONS