HARDNESS TESTER PROPOSAL

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Current operations in the PF line have been experiencing issues with twisting cables and difficulties during the bending, straightening, and cutting portions of the pre and post solder process. The goal of this presentation is to emphasize the importance of hardness testing and why we need it at CFS. Firstly, I will be discussing our problems.

STRAIGHTENING AND BENDING

During the bending and straightening portion of pre-solder, technicians have observed that when bending or straightening, the compression from the 5- or 10-ton piston causes a twisting effect on the jacket and the copper petals.

SEAM AND ORBITAL CUTTING

Since the cable is now coming into cutting not fully straight and slightly twisted, there are difficulties with keeping a straight cut even after using K-twist and using Pitbull clamps.

The Pitbull clamps only slightly fix this issue due to the slight bends over varying regions of the cable.

INTERNAL TWIST

When measuring Twist Pitch at Datums for two different cables, a difference of ~10mm was seen, but more data is needed. Although this has been deemed a none issue. PF1-3 has a twist pitch of 220mm, which is outside of spec.

HARDNESS

Hardness variances are noticed at different sections of cable which can lead to decreased tool life, higher blade wear, higher heat generation, inconsistent feed (and cutting rates), and low-quality surface finishes.

“Having an objective, standardized hardness value for a material is important to allow quality control during manufacturing.”

OBJECTIVE

Small Spot Rockwell Hardness Tester

To increase our quality control and check out how much hardness variation, if any, is present throughout the coil.

Ft. Alex Norris

NON-DESTRUCTIVE TESTING

The PF team will be diligent and experiment only on jacket half's that will not affect or be

Continuous Quality inspection improvements

Taking the time to document data will lead to:

- Better decision making
- Risk mitigation
- Increase in efficiency and process refinement

NON-DESTRUCTIVE TESTING

Pre-Orbital Cutter

Taking a sample of the end piece of the Jacket half before orbital cutting will be a good baseline for what the hardness should be.

Straightening and Joggle bends

Taking Jacket pieces from the orbital/seam cutting process will give up data on inner and outer hardness values and will give us the most data on post operation changes in coil structure

Post laser & winding

Before beginning operations in pre-solder, sampling the end points at welds and around welds for changes in material hardness

Post Solder

After Heating the coil up to 200C and having phase change occur inside of coil checking the jacket at Datum will give the best data point for if oven operations are affecting coil structure

WHAT'S THE PROCESS?

Verify Sample area for use

Make sure that sample is within specified area of use. Sample should also be free of any surface defects by polishing surface with sander.

Secure Sample

Clamp sample area into place and mount the Hardness Tester perpendicular to the indenter for each indentation location.

Apply preliminary load

Preliminary loads give us a reference point for our zero point and reduce any effects of surface finish in our results.

Perform test

Apply major load for specified time required as per hardness tester specifications and measure load indentation depth.

WHAT WILL BE GAINED

Quality Control

Helps us determine whether we are operating under informed decision making to have the highest safety and quality equipment.

Structural

Data gathered will in turn let us know if the PF coil will work as expected further down the after pre, solder, and post solder.

Productivity improvements

Helps us do the testing directly in the line and have instant results to maximize our resources and improves overall work cell productivity.

Employees treating CFS like a hobby

Keeps CFS employees happy to do something that will in turn raise productivity, higher employee retention rates, lower cost, and talent acquisition.

CONCLUSION

As you can see there are many problems in the Pre/Post solder area, our goal is to take this opportunity to make this a time of learning and understanding. So, the first step to solve the first of our many future endeavor's is to get our hands dirty and what better way than to keep troubleshooting.

Q&A

Question me?

I’ll Try my best.

RESEARCH OVERVIEW

IF: Isothermal low cycle fatigue

– constant tension or compression at a constant temperature

TMF: Thermal Mechanical Fatigue

-- Combination of mechanical and thermal stresses and can affect the delta ferrite and due to residual stresses can have changes in the metal's microstructure.

DSA: Dynamic Strain Aging

-the mechanism that accumulates damage (over time) during Isothermal fatigue or the increase in the materials response to plastic deformation at specific temps. (For 316 LN 200C to 650 C) only experienced at Oven temps.

https://tinyurl.com/3u83azwj

•"The build-up of damage under IF and TMF cycling is dictated by a combination of DSA and δ-ferrite transformation, depending on the applied strain amplitude and the strain-temperature phasing employed. The observed life variations have been rationalized in terms of the substructural evolution and fracture behavior under different testing conditions."

HTTPS://TINYURL.COM/TIGWELDSS

" TIG weld exhibited higher hardness and strength properties than the base metal and ATIG weld joint due to the existence of higher δ ferrite"

HTTPS://WWW.SCIENCEDIRECT.COM/SCIENCE/ARTICLE/ABS/PII/S1350630719308003

"As the bending angle increases, tensile transverse stress on outer surface increases." "The hardness value increases as the bending angle increases."

HTTPS://WWW.MACHININGDOCTOR.COM/MDS/?MATID=1790

•"In case you are running at a cutting speed that is lower than 390 SFM (120 m/min), it is better to use a grade with a **Semi Hard substrate and PVD coating."**

•"For general **Milling** use a grade with a **Semi Hard substrate and PVD coating."**

•"For **detailed carbide grades recommendations**, check the Below Chart, or use the **Grades Wizrad**."

THANK YOU

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3246303/

https://www.researchgate.net/publication/343591674_Cold_bending_effect_on_residual_stress_microstructure_and_mechanical_properties_of_Type_316L_stainless_steel_welded_joint

https://www.xometry.com/resources/materials/hardness-testing

https://www.sciencedirect.com/science/article/abs/pii/S1350630719308003

https://www.titltest.com/blogs/articles/the-importance-of-hardness-testing-in-various-industries

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7602276/

https://www.ctemag.com/articles/turning-hard-way

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https://www.makeitfrom.com/material-properties/AISI-316LN-S31653-Stainless-Steel

https://www.scielo.br/j/mr/a/k68Lk3gPfTqDLMKb67xSCkx/?lang=en