Nitriding Fixture for Spline and Quill Shafts
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Executive Summary
The goal of this project is to design a safety focused fixture that can undergo the nitriding process while supporting three splined shafts and one quill shaft.

The nitriding process increases surface hardness, friction, and resistance of the material to corrosion of the four shafts.

The design process for the fixture included material selection, thermal analysis, finalizing dimensions through calculations and simulations, and creating engineering drawings for each part.

Material Analysis
Stainless Steel 330 (bulk material)
Material Strength at 1000°F: 37700 psi
Thermal Expansion (α): 9.28 μ-in/°F
Corrosion: 18-20% chromium

Stainless Steel 316 (bolts, nuts, and U-bolts)
Material Strength at 1000°F: 27500 psi
Thermal Expansion (α): 9.72 μ-in/°F
Corrosion: 16% chromium

Cost Analysis
Stainless Steel 330 (bulk material)
~$23.89 per lb. *
Stainless Steel 316 (bolts, nuts, and U-bolts)
Nuts: $2.00
Bolts: $15.82
5/8” U-bolts: $95.92
7/8” U-bolts: $217.93

*Cost was determined on a per lb. basis, however material will be purchased in plates, sheets, bars, etc.

Structural Analysis
Factor of Safety of Spline Attachment

Weld Strength Equation (Filler: Inconel 82)
P = σ_c L_eff t cos(45°)
Weld Strength: P = 14576 lbs
Allowable Connection Stress*: σ_c = 24 ksi
Effective Length: L_eff = \pi D = 1.96 in
Fillet Thickness**: t = 0.1875 in

*Allowable connection stress (σ_c) determined from AWS D1.1 standards.

**Minimum fillet thickness (t) according to AWS D1.1 standards.

Critical Buckling Load Equation
P_cr = \frac{\sigma_c}{\sqrt{\pi}} \frac{D^2}{4}
Critical Buckling Load: P_cr = 2.5e+05 lbs

Maximum Deflection Due to Eccentricity Equation
\Delta y = \frac{P e}{2 E I} + \frac{P l}{2 E I} + \frac{P l}{2 E I}
Support Column Deflection: y_max = 1.409 in
Note: for maximum eccentricity value e = 0.812 in

Future Recommendations
The fixture could be used for nitriding of similar shafts which could be set on the bottom plate instead of the quill shaft. Use caution with the size of the clevis used to ensure Splined shafts don't drag on bottom plate. Temperatures significantly higher than 1000°F may threaten the structural integrity of the fixture.

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