CASE STUDY

CURING A BOOSTER PUMP JOINT FACE LEAK

BY: M. Jeratowski – MidAmerican Energy
S. Golinkin, J. Silvaggio, R. Mayberry – SIEMENS (Engineering)
SINGLE STAGE, DOUBLE SUCTION BOOSTER PUMP

OPERATING CONDITIONS

LIQUID: SUPERHEATED WATER
TEMPERATURE: 337 °F
SUCTION PRESSURE: 212 PSIG
DISCHARGE PRESSURE: 373 PSIG
ROTOR SPEED: 1,780 RPM
REQUIRED HORSEPOWER: 551 HP
PUMP WITH ORIGINAL HORIZONTAL JOINT (STANDARD STUDS AND CAPNUTS)

LEAKAGE IS SHOWN IN THE FORM OF STEAM BECAUSE OF SUPERHEATED WATER BEING PUMPED
Major Items Considered for the Reliability of Bolted Joints

1. Quality of flange contact surfaces:
   • Surface finish
   • Flatness
   • Quality of the gasket (thickness & types)

2. Quality of thread engagement
   • Surface finish (galling)
   • Geometry

3. Non-parallelism of seating faces (flange, spot face, capnut) and perpendicularity of the bolted hole to seating faces

Potential Accumulative Angular Deviations from Design in Bolted Horizontal Joint

\[ \varphi = \alpha + \beta + \gamma \]
SUMMARY

PROPOSED BOLTING IMPROVEMENTS

1. Advanced stud design:
   - Optimized configuration.
   - Cold rolled thread.
   - Increased length of stud-to-case thread engagement.

2. Bottom down stud support (better load distribution between threads).

3. Advanced thread tensioner: controlled and accurate preload in restricted area, stud is tightened in pure tension. Simple hand tools for installation.

ORIGINAL FEATURES

1. Existing Stud Design:
   - Non-optimized configuration.
   - Mechanical machined thread.
   - Insufficient length of stud-to-case thread engagement.

2. Stud jammed into threaded end of case hole.

3. Uncontrollable and inaccurate hand torqued capnut in restricted area.
ADVANTAGES OF ROLLED THREADS VERSUS MACHINED THREADS

1. Increased tensile strength (by at least 10%):
   – Resistance to cracks due to work-hardened surface of the thread.
   – Rolling does not cut through the material fibers.

2. Increased shear strength because material fibers/grains are not damaged/destroyed by rolling.

3. Significantly Improved wear characteristics and antigalling properties:
   – High hardness.
   – Excellent surface finish (32 finish or better).
REWORK PROCEDURE

ORIGINAL HORIZONTAL JOINT WITH STANDARD STUD AND CAPNUT

REMACHINEING OF ORIGINAL HOLE

IMPROVED HORIZONTAL JOINT WITH ADVANCED STUD AND TENSIONER

ORIGINAL CAPNUT

ORIGINAL STUD

FLAT BOTTOM DRILL

PILOT DRILL JIG

ADVANCED TENSIONER

IMPROVED STUD

ORIGINAL STUD

IMPROVED STUD

IMPROVED HORIZONTAL JOINT WITH ADVANCED STUD AND TENSIONER
IMPROVED HORIZONTAL JOINT WITH UPGRADED BOLTING (ADVANCED STUDS AND TENSIONERS)

NO LEAKAGE AFTER BOLTING UPGRADE!
PUMP OPERATION BEFORE AND AFTER UPGRADE

HORIZONTAL JOINT WITH ORIGINAL STUDS AND CAPNUTS

IMPROVED HORIZONTAL JOINT WITH ADVANCED STUDS AND ADVANCED TENSIONERS

STEAM LEAKAGE

NO LEAKAGE
CONCLUDING REMARKS ON ADVANCED TENSIONERS

ADVANTAGES

1. Tightens in pure tension (no thread galling).
2. Accurate preload (±5%).
3. Holding power: joint remains tight at vibration, thermal/dynamic cycles.
4. Fits in restricted areas
5. Very forgiving design.
6. Safe to use.
7. Hand tools (torque wrenches and air wrenches) required.
8. Time and labor savings.

- Torque applied to jackbolts
- Tensioner assembly spun on hand tight
- Hardened washer
  Protects joint surface
- Joint is clamped tight
- Existing bolt/stud is tightened in pure tension
ADVANCED TENSIONERS

Low torque for Advanced Tensioners

<table>
<thead>
<tr>
<th>Torque Curve for 45,000 psi Bolt Stress</th>
</tr>
</thead>
<tbody>
<tr>
<td>Torque Required For Standard Nut</td>
</tr>
<tr>
<td>Torque Required For Advanced Tensioners</td>
</tr>
</tbody>
</table>

Thread Diameter (In.)

100,000

50,000

ADVANCED TENSIONERS AFTER TIGHTENING

Partial Transfer Of Load To Top Of Nut (End Of Stud)

Jackbolt Tread At Top Of Nut Beneficial To Load Transfer

No Stress Concentration Under Load At Bottom Of Nut

BETTER LOAD DISTRIBUTION BETWEEN THREADS