Engineered Re-Rate of SWI Pumps for Produced Water Service

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Agenda

SWI to Produced Water – An Explanation

- Pump Modifications
  - Wear Rings
  - Base-plate
  - Bearings
  - Sealing
  - Performance
- Project Lessons Learned
What is Produced Water? Why is it a Problem?

- Produced Water – Combination of contaminated injection and formation water
- Formally discharged into sea
- Now carefully controlled and re-injected into well
- No emission of formation water allowed
- Zero Emission Sealing Solution Required

The challenge for PSN and Union together was to re-engineer the existing SWI units to meet the produced water duty requirements.
Summary of Re-Rate Parameters for SWI and Booster

- **Metallurgy:** Wear ring metallurgy had to be modified to incorporate a hard HVOF coating as particulate contamination was anticipated in the re-injection service.

- **Sealing:** The existing sealing methodology did not give zero fugitive emissions of the pumpage. A plan 53C pressurized seal system was used with double mechanical seal to guarantee the zero emissions.

- **Base-plate:** Anti vibration mountings required on the base-plate and the existing base was not suitable for this conversion

- **Bearings:** The existing bearings were self contained sleeve tilting pad type with a lubricating/pumping mechanism incorporated into the bearing design. These had suffered from poor reliability on the platform. The existing bearing housing were modified and re-engineered and their lubrication system replaced with a skid mounted lube oil system.
Summary of Re-Rate Parameters for SWI and Booster

- **Discharge Pressure**: Dramatically reduced from the existing service. Re-injection pressures are commonly lower than the original SWI duty conditions.

- **Re-rate of head**: Easy to accommodate by de-staging the unit and reducing the impeller diameters.

- **Spare Cartridge**: included in the scope of supply. All hydraulic components were checked using Computation Fluid Dynamics to assess the potential for hydraulic changes to refine the unit performance.
Images of Re-Engineered Pumps

OH2 Booster
Wear Ring Modifications

- Case and Hub Rings Modified
- Resistance to Particulate damage Required
- Silicon Carbide Coating applied to Wear ring surfaces
- HVOF application with pulling resistance of greater than 1000psi
- Coating hardness 1000 BNH
Sealing Modifications

- Pressurised Sealing System – Constant Delta Pressure
- 1-2 bar above product sealing pressure
- Tracks the product sealing pressure
- SS construction
- Requires no nitrogen
- Plan 53C
Base-plate Modifications

- Flexible Deck on platform requires Anti-vibration Mountings
- Base-plate damaged on removal – Extra stiffening plate added
- Internal piping previously used for cabling removed
Base-plate Modifications

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Bearing Modifications

- Poor reliability of existing equipment reported.
- Self contained lubrication system within the bearing was prone to failure.
- Preference for Lube-oil system expressed after contact finalised – late modification.
- Bearing modifications required to facilitate LO system.
Discharge Pressure Re-Rate

- Benchmark testing
- CFD Evaluation of Existing Geometry
- De-Staging to 7 stages from 9 stages
- New trim levels established after benchmark testing
- CFD re-design to improve efficiency.
Barrel Pump Performance Curve – After Re-rate
Lessons/Problems

- Re-engineering is technically more time consuming than engineering a new piece of equipment for the same service.
- Frank and open discussion at weekly progress meetings benefited both sides.
- Scope of supply - creep accommodated within project timeline as a result of early identification and acceptance. No concessions sought!
- Shipment of pump skid to site prior to pump test allowed site work schedule to be kept on track.
- Unconventional approach from both sides.
Conclusion/Recapitulation

- Hydraulic modification of SWI and Booster Performance for Produced water re-injection Service
- Bearing Modifications to improve reliability
- Seals modified for zero Emissions with Plan 53C
- Base plate modified for Anti-Vibration mounting
- Close working relationship between contactor and manufacturer key to achieving project timeline
Questions