ABRASION AND CORROSION PHENOMENA ENCOUNTERED WHEN DREDGING HARD SOIL

SIM User Forum – 19 November 2014 – Arjen VAN DEN BOS
Backhoe dredger
Bucket of backhoe dredger
- Hardfacing: expensive and labour-intensive
- Domite wear pieces welded on the side wings of the bucket
Trailing suction hopper dredger
Trailing suction hopper dredger
Dredge pumps and dredge lines
Hopper abrasion and corrosion: replaced 65t of steel after 5 years
Cutter suction dredger
Cutter suction dredger
Cutter suction dredger

- New cutter head and teeth
Cutter suction dredger

- New cutter head and teeth
Cutter suction dredger

- 10 minutes later ...
Dredge pipelines
Dredge pump impeller

- New impeller
Dredge pump impeller

- Worn-out impeller
Dredge pump casing
Dredge pump parts
- As soon as the flow stops, corrosion starts
- Combined effect of abrasion and corrosion
Subsea rock installation vessel
Subsea rock installation vessel
Subsea rock installation vessel

- Steel pipes with PU liner
  - Reduced weight / submerged weight
  - Not possible to repair
  - Limited number of suppliers
Ballasting offshore structures
Ballasting offshore structures

- Pumping Magnadense
- Heavy abrasion
- Test setup recirculating 100 tons of material: little abrasion
Wear and tear mechanism

Types of wear and tear

- Abrasion
- Impact
- Cavitation (dredge pump)
  - Imploding bubbles
  - Popping or rumbling noise and vibration
  - Often masked by abrasion
- Corrosion
  - Corrosion caused by seawater
  - Often masked by abrasion
  - Combined effects of corrosion and abrasion
- Fatigue (cutter shaft, spuds, pump casing)
Most important and interdependent factors of abrasion:

1. Soil / Slurry characteristics
2. Material characteristics
3. Operating characteristics
1. **Soil / Slurry characteristics**

   - Limited number of borings, hardly 1 m³ of material extrapolated
   - Soil is a heterogeneous material
   - Quality of the execution of borings and tests
   - Disguising of the real results
   - Degradation particle size and shape during cutting and pumping
   - Execution of the job is not done in a clean lab environment
Factors of abrasion

2. Operating characteristics

- Relative velocity and volumetric concentration: wear $\sim (\text{particle-velocity})^3$
- Swing-speed of cutter suction dredger
- Velocity of cutter head
- Velocity of the impeller: wear $\sim (\text{tip-velocity impeller})^3$
- Dredge pump optimal operation
- Pipeline layout
3. **Material characteristics**

- **Common carbon steel (low abrasion resistance - high toughness)**
  - Can withstand high pressure and is very good weldable

- **Cast iron and cast steel (higher abrasion resistance - lower toughness)**
  - NiCr, Cr-Mo and high Cr alloys
  - Dredge pump parts, cutter heads, cutter teeth, liners for pipelines

- **Elastomers: rubbers and urethanes (higher abrasion resistance - higher toughness)**
  - Liners and connections that have to be flexible
  - Lower weight, lower submerged weight

- **Ceramics (high erosive resistance - low toughness and low impact resistance)**
  - Liners in certain high wear components
  - Inserts in jet water nozzles
Material selection: challenges

- Compromise
  - Wear resistance
  - Strength
  - Ease of maintenance
  - Direct and indirect cost
  - Effect on system efficiency

- Uncertainty: soil, operations, material

- Comparing materials and developing new materials
  - Limited info on new material: no real life test data
  - No repeatable conditions
  - No combined effects
  - Logistical/operational flow until feedback/results
Thank you for your attention