4. CSD: CUTTER SUCTION DREDGER

BY PIETER DEN RIDDER

Dredging...?
Double production…!

Equipment

- Breakdown of the dredging process
- Overview of dredgers
  - Cutter suction dredger
  - Trailing suction hopper dredger
  - Backhoe dredger
  - Grab dredger
  - Other equipment
  - Environmental dredgers
Breakdown of the Dredging Process

- Loosening the material (and/or dislodging)
- Picking up the loosened material
- Transport
  - through the primary dredger
  - further transport
- Disposal of the material
  - under water
  - on shore

Means to realise the partial processes

- Hydraulic (erosion, discharge pipe, etc.)
- Mechanical (cutter, conveyor belt, etc.)

Remark
The different sub-processes may require different types of dredging equipment
Overview of dredgers

- Hydraulic/mechanical dredgers (CSD)
- Hydraulic dredgers (TSHD)
- Mechanical dredgers (Backhoe, Grab)
- Environmental dredgers

Hydraulic/Mechanical Dredgers

- Cutter Suction Dredger (CSD)

Cutter Section Dredgers
Based on total installed power

- **Mega**: 23,000kW and over
- **Heavy Duty**: 13,000-23,000kW
- **Large**: 9,000-13,000kW
- **Mid-Size**: 3,000-9,000kW
- **Small**: under 3,000kW
Cutter Suction Dredgers at Suez Canal

- End 2014: Deepening Suez Canal started
- Once in a lifetime cutter job, 250 mln m³ in one year time
- +/- 20 cutter dredgers working at the same time and project

2 Consortia:
- Boskalis, Van Oord, NMDC (Abu Dhabi) and Jan De Nul
- Dredging International and Great Lakes
Cutter Suction Dredgers at Suez Canal

Cutter Suction Dredgers

- Cutter power

Small < 600 kW

Mid-size, 600-1500 kW
Cutter Suction Dredgers

- Cutter power

Heavy Duty, 3000-5500 kW  Mega, 5500-7500 kW

Main characteristics
Most important parts of the dredger
Working principle
Production limiting factors
Some characteristic figures
Cutter Suction Dredgers

Main characteristics

- Nearly all kinds of soils (sand, clay, rock)
- Stationary dredger:
  - vulnerable to shipping
  - sensitive to wave conditions
- Some are self-propelled for mobilisation
Cutter Suction Dredgers

Most important parts, machinery

- Cutter and cutter drive
- Dredge pump(s)
- (Side-) Winches and sheaves for the side wires for swinging

Working principle

- Cutter disintegrates or dislodges the material mechanically by rotating cutter head
- Material sucked up and transported through pipeline by use of centrifugal dredge pumps
The material is dislodged by the cutter head. The dredged material is sucked by the dredge pump. The mixture is pumped through a pipeline to the disposal area.

CSD: Cutting & Pumping

Cutter Suction Dredgers

Working principle
- Cutter disintegrates or dislodges the material mechanically by rotating cutter head
- Material sucked up and transported through pipeline by use of centrifugal dredge pumps
- Pontoon movement by:
  - swinging around working spud
The dredge moves along concentric arcs around the work spud. In order to swing, one side wire is hauled in while the other one is paid out. Often a braking force is exerted with the paying out winch in order to create a stiffer system.

CSD WORK METHOD (1)

Swing to SB
CSD WORK METHOD (2)

Stop at SB, 
Push dredger forward

CSD WORK METHOD (3)

Start swing to PS
CSD WORK METHOD (4)

Continue swing to PS

CSD WORK METHOD (5)

Stop at PS, Push dredger forward
CSD WORK METHOD (6)

Start swing to SB

CSD WORK METHOD (7)

Stop in Centre Line
CSD WORK METHOD (8)

Aux. spud down

CSD WORK METHOD (9)

Main spud up
CSD WORK METHOD (12)

Aux. spud up

CSD WORK METHOD (13)

Start swing to SB
Cutter Suction Dredgers

Working principle
- Cutter disintegrates or dislodges the material mechanically by rotating cutter head
- Material sucked up and transported through pipeline by use of centrifugal dredge pumps
- Pontoon movement by:
  - swinging around working spud
  - progress by successive steps (stepping) and spuds (spudding)

- Summary 3D
When the end of cut is reached, one has to move forward (step) The spud carriage is used for this purpose

Cutter Suction Dredgers

Working principle
- Cutter disintegrates or dislodges the material mechanically by rotating cutter head
- Material sucked up and transported through pipeline by use of centrifugal dredge pumps
- Pontoon movement by:
  - swinging around working spud
  - progress by successive steps (stepping) and spuds (spudding)
CSD: Spudding

The dredger is positioned in the centerline of the cut and the spudding procedure can start.

- The auxiliary spud is lowered
- The work spud is hoisted
- The spud carriage is put in its initial position
- The work spud is lowered
- The auxiliary spud is hoisted
- The swinging process can restart

Working principle

- Cutter disintegrates or dislodges the material mechanically by rotating cutter head
- Material sucked up and transported through pipeline by use of centrifugal dredge pumps
- Pontoon movement by:
  - swinging around working spud
  - progress by successive steps (stepping) and spuds (spudding)

Summary 3D
Cutter Suction Dredger:
cutting & swinging 3D

Process topics
- Over-cutting versus under-cutting
- Spill
- Cutter heads
- Anchors
Cutter Suction Dredger

undercutting

spillage
(cutting deeper than design level)

overcutting

Cutter head
- Back ring - arms - hub
- Blades - teeth: chisels / pick points
- Various shapes

Cutter with chisels
Cutter Suction Dredger

- Sand/clay cutter head
- Rock cutter head

- Anchors
  Depending on soil type

Flipper Delta

Stevshark
Cutter Suction Dredger

Production limiting factors
- Soil characteristics
- Available power on cutter
- Side winches (max. power and velocity)
- Thickness and width of the layer to be dredged
- Dredging depth (ladder angle, spuds, cavitation)
- Pumping distance
  (pump- and pump drive characteristics)
- Shipping
- Waves and currents
- Dirt and debris
Cutter Suction Dredger

Characteristic Figures

<table>
<thead>
<tr>
<th>cutter suction dredger</th>
<th>small</th>
<th>mid-size</th>
<th>large</th>
</tr>
</thead>
<tbody>
<tr>
<td>dimensions (L<em>W</em>Dr)</td>
<td>65 * 10 * 2 m</td>
<td>70 * 16 * 4 m</td>
<td>120 * 20 * 5 m</td>
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<tr>
<td>total power</td>
<td>&lt; 3,000 kW</td>
<td>&lt; 9,000 kW</td>
<td>&lt; 13,000 kW</td>
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<tr>
<td>cutter power</td>
<td>&lt; 600 kW</td>
<td>&lt; 1,500 kW</td>
<td>&lt; 3,000 kW</td>
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<tr>
<td>max. swing speed</td>
<td>19 m / min</td>
<td>32 m / min</td>
<td>32 m / min</td>
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<tr>
<td>max. dredging depth</td>
<td>15-20 m</td>
<td>25 m</td>
<td>25 - 30 m</td>
</tr>
<tr>
<td>discharge diameter</td>
<td>0.35 - 0.70 m</td>
<td>0.65 - 0.85 m</td>
<td>0.75 - 0.85 m</td>
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</table>
Cutter Suction Dredger

Characteristic Figures

<table>
<thead>
<tr>
<th>cutter suction dredger</th>
<th>heavy duty</th>
<th>mega</th>
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<tbody>
<tr>
<td>dimensions ((L<em>W</em>Dr))</td>
<td>125 * 22 * 5 m</td>
<td>140 * 24 * 6.5 m</td>
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<tr>
<td>total power</td>
<td>&lt; 23,000 kW</td>
<td>&lt; 28,000 kW</td>
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<tr>
<td>cutter power</td>
<td>&lt; 5,500 kW</td>
<td>&lt; 7,000 kW</td>
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<tr>
<td>max. swing speed</td>
<td>32 m / min</td>
<td>32 m / min</td>
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<tr>
<td>max. dredging depth</td>
<td>25 - 35 m</td>
<td>30 - 35 m</td>
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<tr>
<td>discharge diameter</td>
<td>0.80 - 0.90 m</td>
<td>0.90 - 1.00 m</td>
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