Company introduction

- Problem description
- Setup and numeric solution
- Conclusion
Erich NETZSCH GmbH & Co. Holding KG

Analyzing & Testing
Thermal analysis instruments and instruments for the determination of thermophysical properties

Grinding & Dispersing
Comprehensive machine program for wet and dry grinding as well as mixing, dispersing, homogenizing and classifying

Pumps & Systems
Always the right positive displacement pump for your application
The NETZSCH Group

- Foundation 1873 by Thomas and Christian Netzsch in Selb
- More than 3500 Employees worldwide
- 534 Mio. € Turnover Fiscal Year 2017/2018 (Fiscal Year: 01.07. – 30.06.)

![Turnover Distribution in FY 2018]

- Analyzing & Testing 18%
- Grinding & Dispersing 31%
- Pumps & Systems 51%

<table>
<thead>
<tr>
<th>Year</th>
<th>Turnover in € million</th>
<th>Employees</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>453</td>
<td>3020</td>
</tr>
<tr>
<td>2014</td>
<td>445</td>
<td>3252</td>
</tr>
<tr>
<td>2015</td>
<td>478</td>
<td>3386</td>
</tr>
<tr>
<td>2016</td>
<td>475</td>
<td>3455</td>
</tr>
<tr>
<td>2017</td>
<td>477</td>
<td>3404</td>
</tr>
<tr>
<td>2018</td>
<td>534</td>
<td>3510</td>
</tr>
</tbody>
</table>
Production, assembly and sales companies
In the region for the region

- 5 manufacturing sites on 4 continents and 3 assembly plants (Singapore; Shanghai (Anting), Brisbane)
- 1 cooperation partner
- 30 sales companies and more than 200 NETZSCH distributors and agents
Product lines

NEMO®
Progressing Cavity Pumps

TORNADO®
Rotary Lobe Pumps

NOTOS Multi Screw Pumps

NETZSCH Macerators

NETZSCH Barrel Emptying Units, Dispensers, 1K-Dosing Systems

NETZSCH Systems*

* Brasil
## Competence in all markets

<table>
<thead>
<tr>
<th>Environmental &amp; Energy</th>
<th>Agriculture</th>
<th>Biogas</th>
<th>Construction Industry</th>
<th>Drinking Water Purification</th>
<th>Electroplating</th>
<th>Marine</th>
<th>Wastewater Treatment</th>
<th>…</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical, Pulp &amp; Paper</td>
<td>Biofuels</td>
<td>Ceramics and Glass</td>
<td>Chemical and Biochemical</td>
<td>Explosives</td>
<td>Leather / Tanneries</td>
<td>Mining</td>
<td>Paint and Varnish</td>
<td>Pulp and Paper / Cellulose</td>
</tr>
<tr>
<td>Food &amp; Pharmaceutical</td>
<td>Bakery Products and Sweets</td>
<td>Beverages</td>
<td>Breweries, Wine</td>
<td>Dairies</td>
<td>Fish and Meat Processing</td>
<td>Fruit Processing</td>
<td>Pharmaceutical and Cosmetic Products</td>
<td>Sugar and Starch</td>
</tr>
<tr>
<td>Oil &amp; Gas Upstream</td>
<td>Single / Multiphase</td>
<td>Oil Extraction</td>
<td>Coal Bed Methane (CBM)</td>
<td>Well Dewatering</td>
<td>Coal Seam Gas (CSG)</td>
<td>Well Dewatering</td>
<td>…</td>
<td></td>
</tr>
<tr>
<td>Oil &amp; Gas Mid-/Downstream</td>
<td>On-/ Offshore</td>
<td>Single / Multiphase Oil Pumping</td>
<td>Oil Processing (FPF)</td>
<td>Petrochemical</td>
<td>Refineries</td>
<td>Tank Storage</td>
<td>…</td>
<td></td>
</tr>
<tr>
<td>Customer Service</td>
<td>Comissioning</td>
<td>Maintenance</td>
<td>Service</td>
<td>Retrofit</td>
<td>Technical Training</td>
<td>Original NETZSCH Spare Parts</td>
<td>Global Service Network</td>
<td></td>
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Explicit problem description

Problem description

- Flow behavior during cavitation unknown
- Is a CFD calculated NPSH performance curve comparable to reality?

Task

- Calculate a progressing cavitiy pump in a point of cavitation
- Comparison with measured performance curves
- Investigate the possibility to generate NPSH curves with CFD for other sizes and geometries

CFD <-> Reality?

NPSH sizing?
Workflow

- Create geometry → faces (intersection of 3D assembly)
- Export as IGES
- Define mesh in TwinMesh
- Generate meshes
- Define the most important Ansys-Pre parameter in TwinMesh
- Export meshes from TwinMesh
- Generate static meshes
- Import all meshes in Ansys and complete Pre-parameter
- Run Solver
- Interpret results and check correlations
Basic geometry is a simple 2D surface (section of rotor/stator)

Creation of a 2D mesh which leads to a 3D mesh

Shown in the picture is the min. angle to determine the quality of the mesh

For this pump type, radial interfaces are not necessary

Clearance between rotor and stator 10 mm
- **Mesh statistics**
  - **Rotor**
    - ~ 3500 elements (2D)
    - ~ 1.75 mio. elements (3D)
    - Min. angle > 52° (360° movement)
    - Only hex. elements
    - Mesh generation time ~ 45 minutes @ 8 cores (Xeon X 5570) and 360° rotation
  - **Stator**
    - ~ 620k elements
    - Mostly tets and weds
Boundary conditions

- Rotational speed: 400 rpm
- Inlet pressure: 0.2 Bar abs.
- Outlet pressure: 1.2 Bar abs.
- Phases: Water & water vapor
- Solver control: 10 iterations per step
- Simulation time: 100 h/rev @ 8 cores Xeon X 5570
CFD – Results

Q_{CFD} = 2.4 \text{ kg/s} \rightarrow \sim 8.6 \text{ m}^3/\text{h}

Q_{th} = 8.88 \text{ m}^3/\text{h}

\sim 2.7 \% \text{ loss of flow}

- Cavitation is meant to occur at 3\% flow drop (there are other definitions, too, but this is a common one) @ 1 \text{ Bar differential pressure}
- The measured values were nearly the same as the calculated ones
- Caution: No rubber deformation is considered

- Vapor distribution of one step
- Red color = water vapor
- Starting points for improvement can easily be found
Volume vapor fraction of a cavitating pump

What can be observed:

- The development of vapor
- Vapour, driven through the pump
- Spots, where vapor voids last longer, can be identified
Additional information such as velocity and hydraulic forces on the stator can be used for further evaluation:

- Load calculation on pump parts (housings, pump feed, etc.)
- Flow guidance optimization
- Etc.
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Conclusion
Conclusion

Tasks from the beginning
- Calculate a progressing cavity pump in a point of cavitation
- Comparison with measured performance curves
- Investigate the possibility to generate NPSH curves with CFD for other sizes and geometries

Results
- Deeper look inside the pump during operation, especially flow behavior
- Starting point for correlations to other sizes
- First spots of possible improvements identified
- Hydraulic loads for further calculations

You can rely on NETZSCH.