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Pumps & Systems

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Cavitation calculation of a progressing cavity pump

Thomas Schmitt, 28.10.2019

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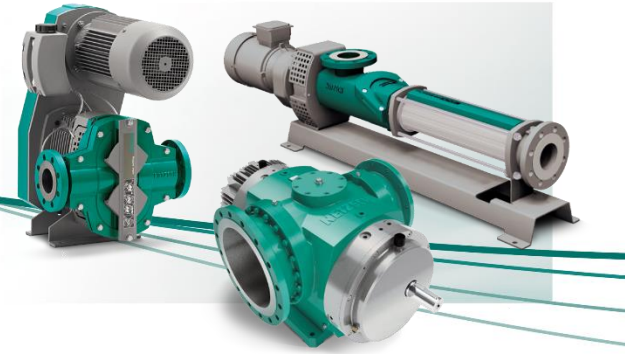
Erich NETZSCH GmbH & Co. Holding KG

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

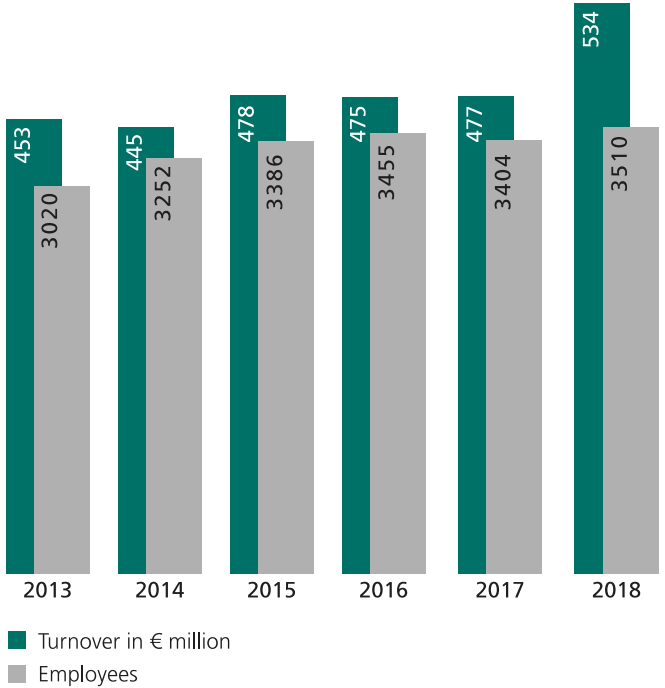


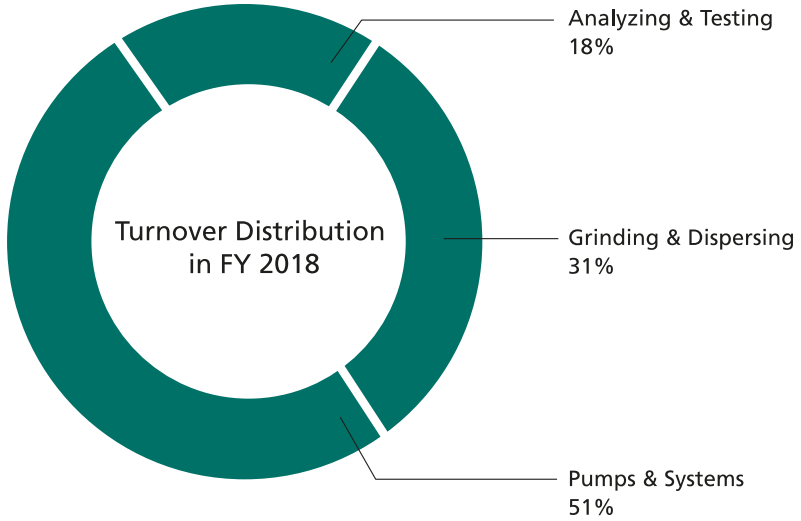
Pumps & Systems

Always the right positive displacement pump for your application

The NETZSCH Group

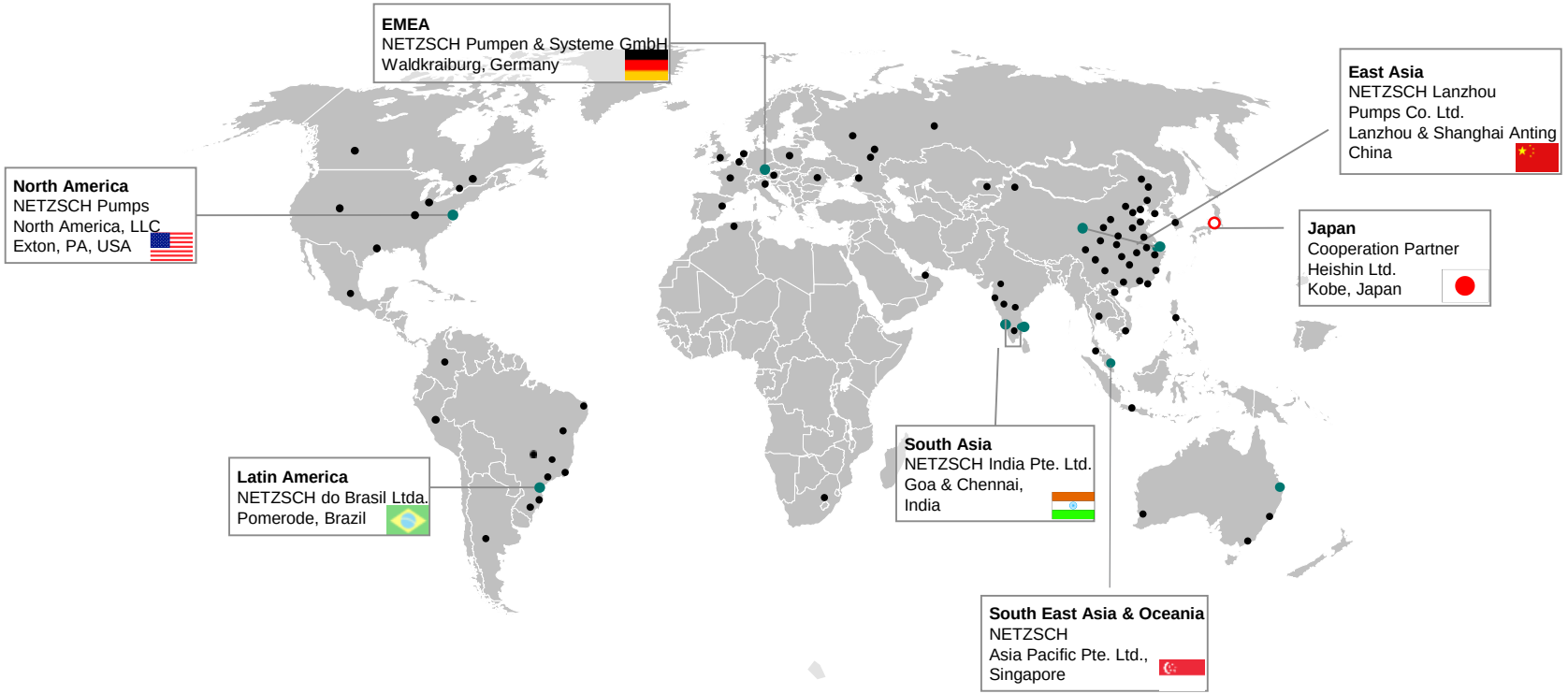
- Foundation 1873 by Thomas and Christian Netzsch in Selb
- More than 3500 Employees worldwide
- 534 Mio. € Turnover Fiscal Year 2017/2018 (Fiscal Year: 01.07. – 30.06.)





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
Artificial

NETZSCH Macerators

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

NETZSCH Systems*

** Brasil*

Competence in all markets

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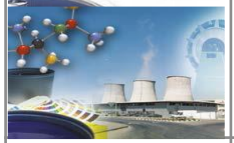
	Environmental & Energy	▪ Agriculture ▪ Biogas ▪ Construction Industry	▪ Drinking Water Purification ▪ Electroplating ▪ Marine	▪ Wastewater Treatment ▪ …
	Chemical, Pulp & Paper	▪ Biofuels ▪ Ceramics and Glass ▪ Chemical and Biochemical	▪ Explosives ▪ Leather / Tanneries ▪ Mining	▪ Paint and Varnish ▪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

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Explicit problem description

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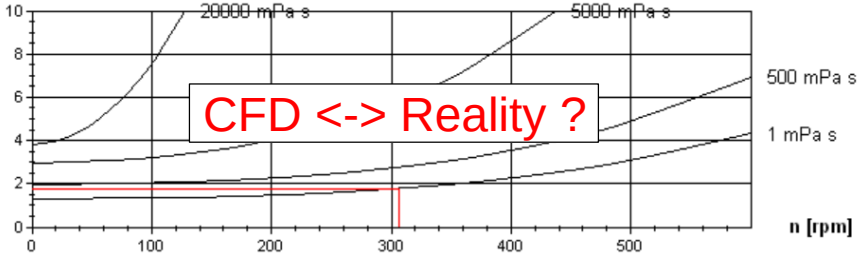
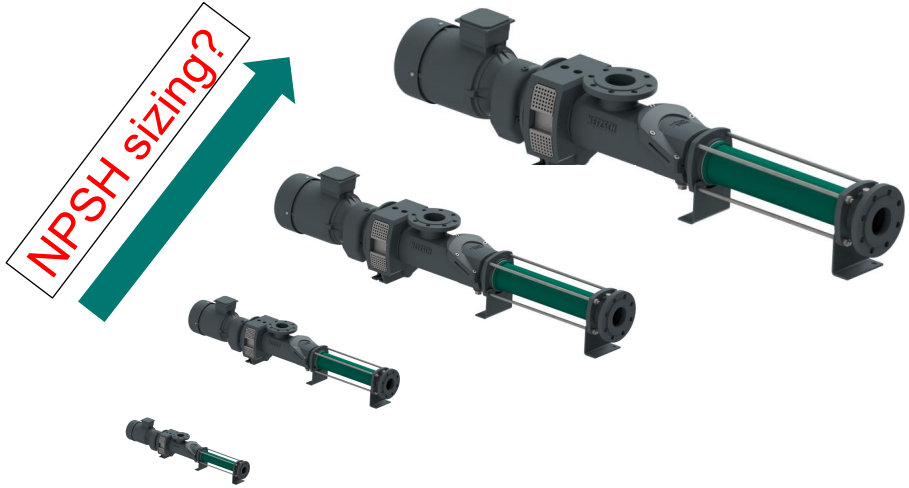
Problem description

- 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 possiblity to generate NPSH curves with CFD for other sizes and geometries





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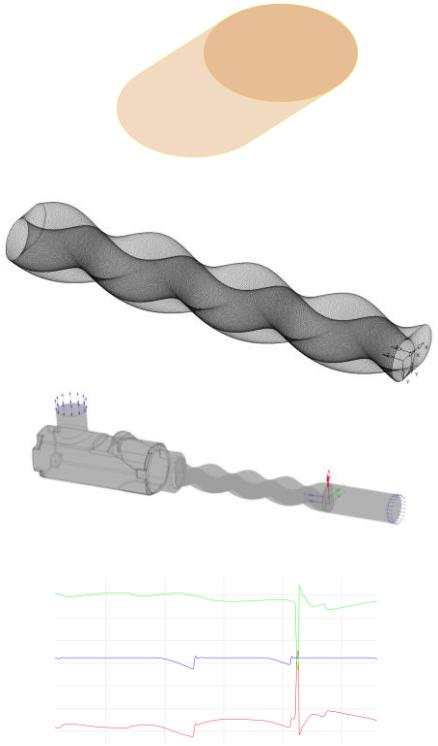
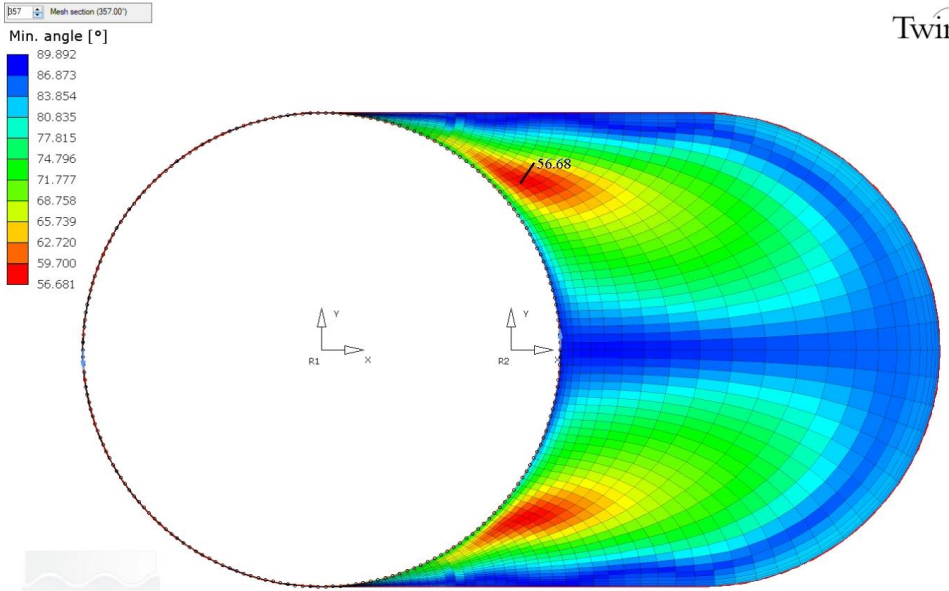
- Create geometry → faces (intersection of 3D assembly)
- Export as IGES
- Define mesh in TwinMesh
- Generate meshes
- Define the most important Ansys-Pre parameter in TwinMesh
- Export meshes from TwinMesh
- Generate static meshes
- Import all meshes in Ansys and complete Pre-parameter
- Run Solver
- Interpret results and check correlations

ANSYS TwinMesh™ ANSYS

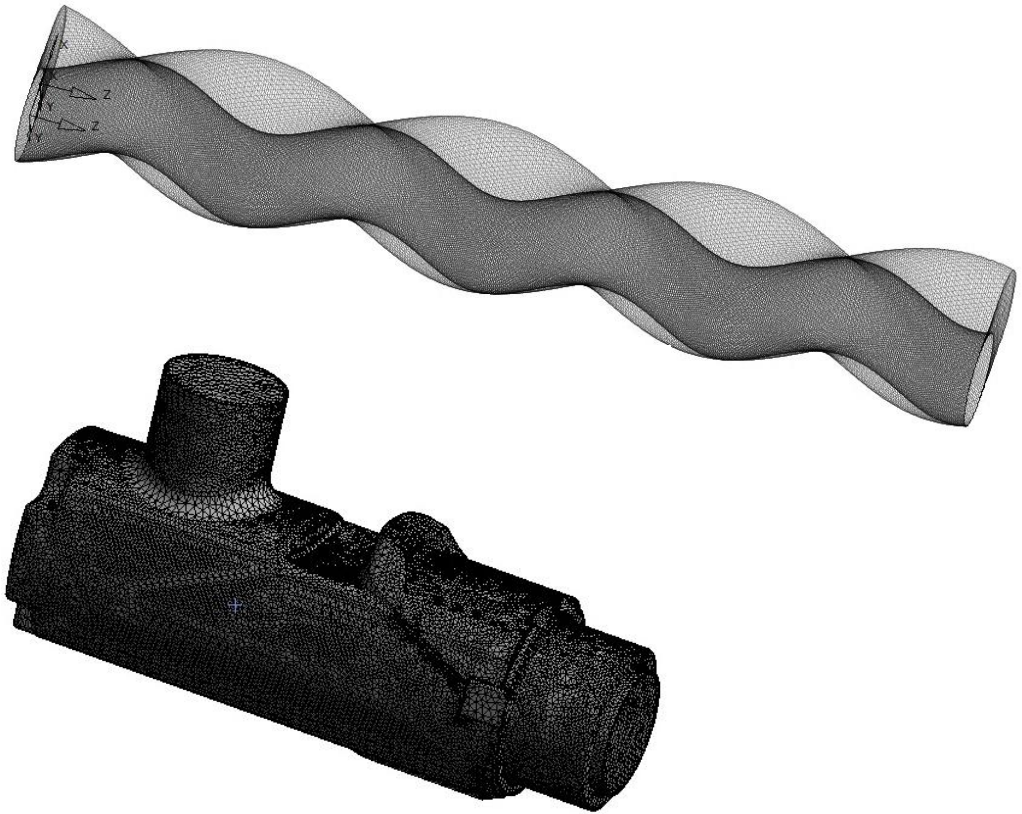


Twinmesh



TwinMesh™

- 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 neccesary
- 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

CFD – Setup

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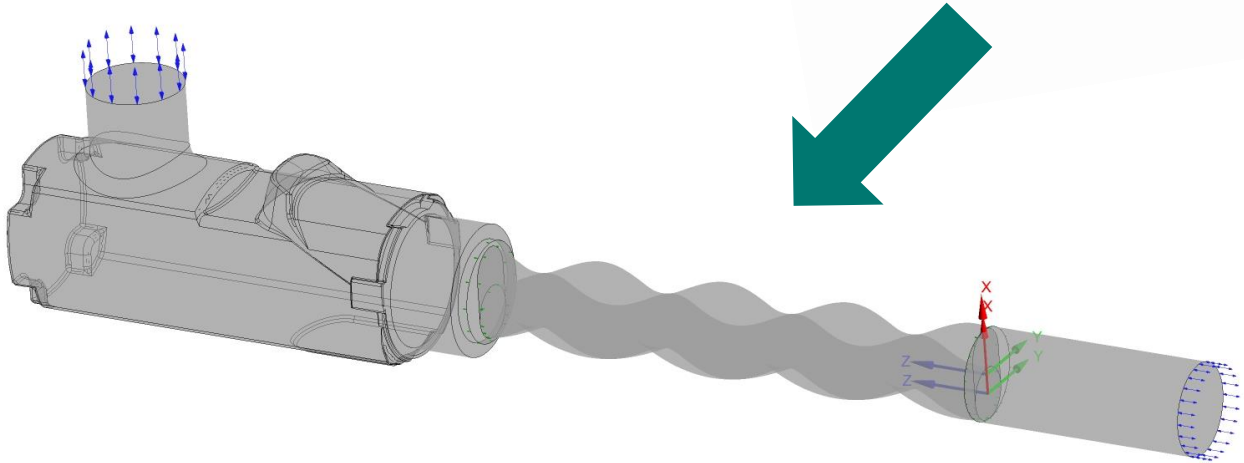
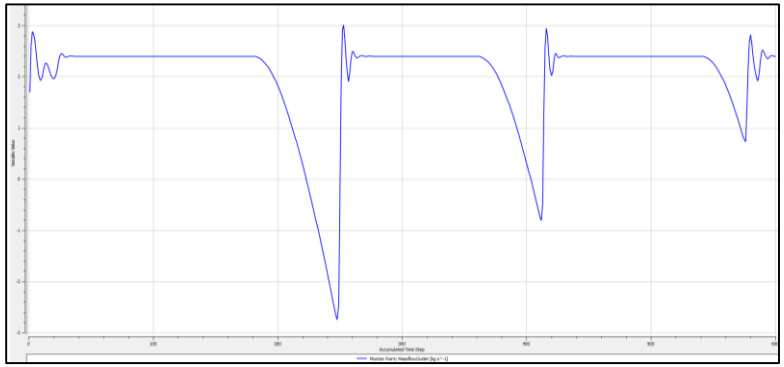
Boundary conditions

- 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

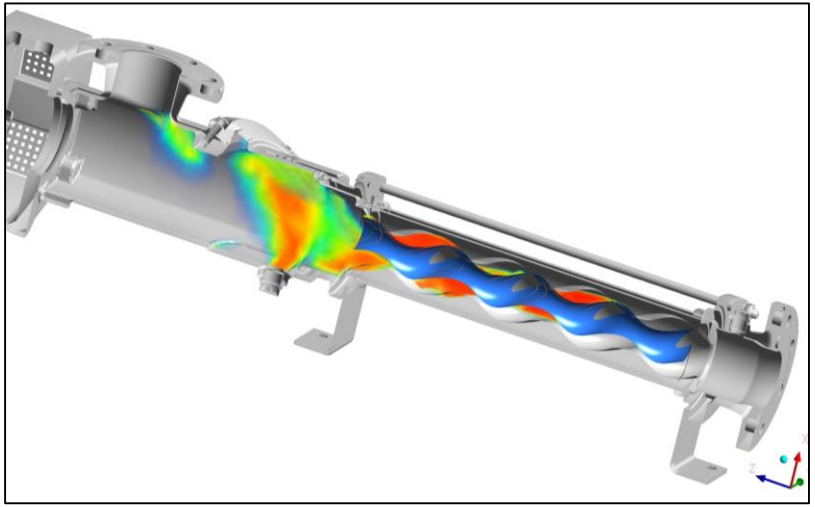


Calculated massflow(outlet)

Q_{CFD} = 2,4 kg/s → ~ 8,6 m³/h

Q_{th} = 8,88 m³/h

~ 2,7 % loss of flow

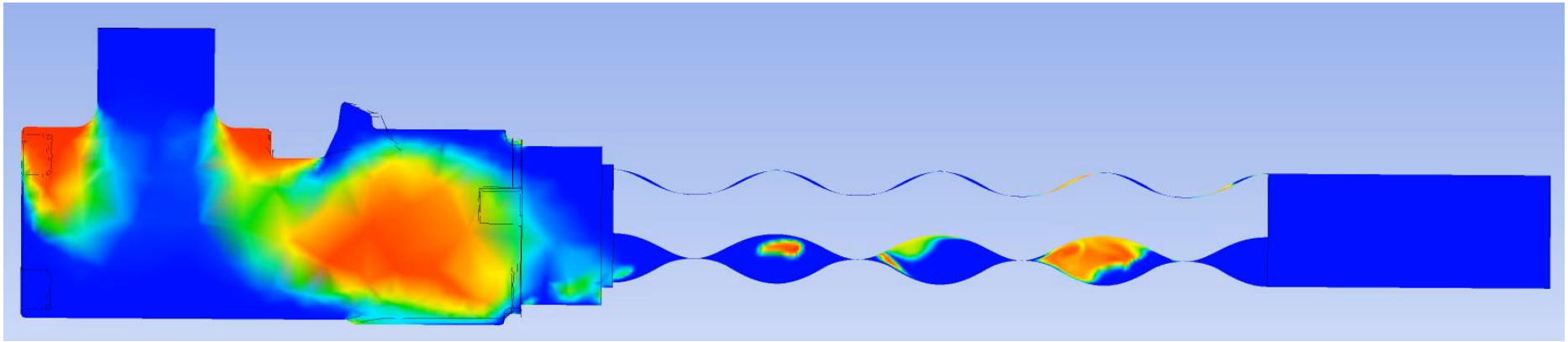


Vapor volume fraction

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

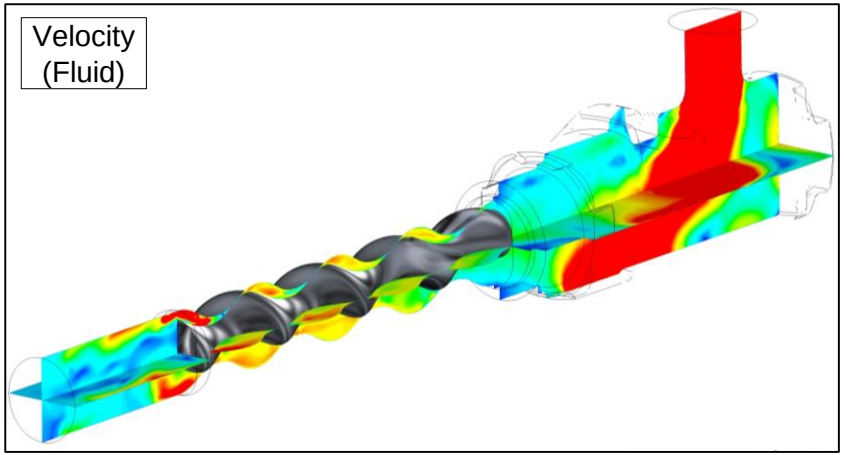
- Vapor distribution of one step
- Red color = water vapor
- Starting points for improvement can easily be found

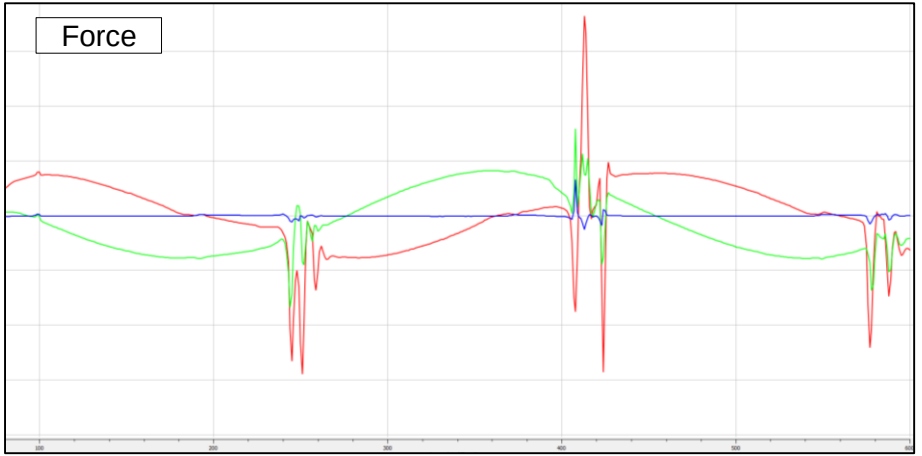
CFD – Results



- 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

CFD – Results





- 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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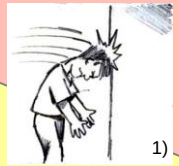
Conclusion

Results

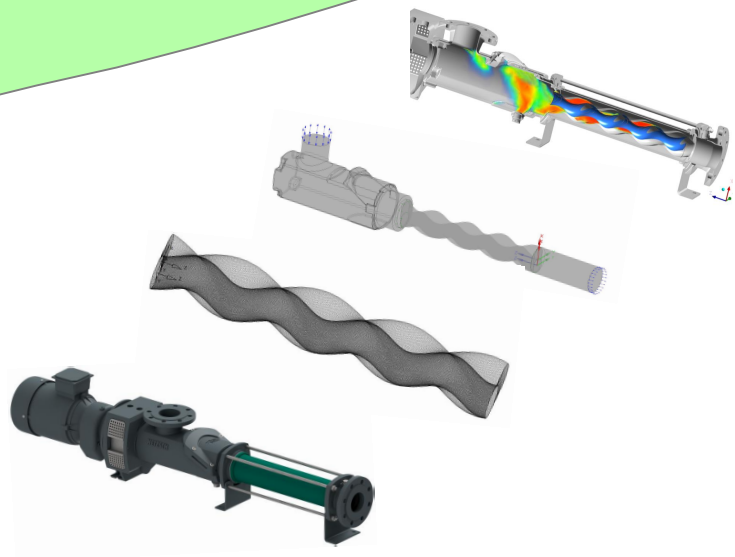
- Deeper look inside the pump during operation, especially flow behavior
- Starting point for correlations to other sizes
- First spots of possible improvements identified
- Hydraulic loads for further calculations

ANSYS



1)

TwinMesh™



Tasks from the beginning

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

1) Source(picture): https://www.ttf-elsdorf.de, 19.09.2019

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