Vom Betriebspunkt zur kennfeldbasierten Dichtungsauslegung

WOST 2019
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Content

1 | Introduction
2 | Motivation
3 | Seal Simulation
4 | Scalar Based Evaluation
5 | Signal Based Evaluation
6 | Field Based Evaluation
7 | Results and Outlook
8 | Summary
Introduction - EagleBurgmann at a glance

Revenue

Leading market position with experience in sealing technology for more than

Strong backbone a member of EKK/Freudenberg since 2004

789.4 million Euro

130 years

Balanced product portfolio

Mechanical Seals
Seal Supply Systems

Specialties

Expansion Joints

Production worldwide

Manpower

20 production sites

5,550 employees

Worldwide presence

60 subsidiaries, 132 service centers and 162 sales offices

in more than 60 countries
### Introduction – Product range

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<thead>
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<th>Specialties</th>
<th>Expansion Joints</th>
</tr>
</thead>
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- **Mechanical Seals**
  - for pumps
  - for agitators

- **Specialties**
  - Mechanical seals for compressors (DGS)
  - Carbon floating ring seals

- **Expansion Joints**
  - Metall expansion joints

- **TotalSealCare**

- **Magnetic couplings**

- **Seal supply systems**

- **Gaskets & Stuffing box packings**

- **Special products & couplings**

- **Fabric expansion joints**
Motivation

30 Years ago:

- Water
- $v_g = 48 \text{ m/s}$
- $\Delta p = 100 \text{ bar}$
- $t_E = 55 \text{ °C}$
- Cost of downtime: ~ 10,000,-

Today:

- Multiphase
- $v_g = 3 - 100 \text{ m/s}$
- $\Delta p = 10 - 250 \text{ bar (400 bara)}$
- $t_E = -20 - 250 \text{ °C}$
- Cost of downtime: ~ 1,500,000,-
Seal simulation

- Leakage
  - Minimize leakage!

- Deformation
  - Minimize taper!

- Gap
  - Avoid strong contact!

- Stability criterion
  - Avoid large negative values!

- One operating point

- 4 – 8 field parameters
- Different critical location
- Changing location depending on application
Seal simulation

• 50 geometry parameters
• 8 discrete forces
• 4 boundary conditions
• 6 material properties
• 4 calibration parameters
• 8 dependent or correlating parameters
• TOTAL: 85 Parameters

2d coupled fluid-structure solver designed to calculate mechanical seals.

• Typical execution time: Minutes!
• Unlimited parallel execution

• Define dependencies and correlations
• Geometry tolerances according to drawings
• Get information from additional calculations
• Extract data from company standards
• Fall back to best practice and literature
• Document sources and values
• Most time consuming part of the workflow
Scalar based evaluation

Nominal input for field

Varying input for single OP

Simulation framework

Nominal performance for field

OptiSlang Postprocessing
Varying performance for single OP
Signal based evaluation

- Limits of current approach: Parameter identification
- Solution: Signal processing – calibration (Dynardo tutorial)
  Use one signal for fit
  Use other signal for validation

Very successful!

Custom Integration!
Python implementation

Extract scalars and signals

Reference signal

Replace-Constant-Parameter:
Dynardo custom algorithm
Alternative: Sensitivity
Signal based evaluation

- "Performance at a glance"
- Identify anomalies and localized effects

Strictly local

Changing importance
Field based evaluation

- Extend existing system (36 – 110 designs)
- FMOP based on designs (Alternative: MOP, AMOP)
- Evaluate signals and fields from single run

Custom node provided by Dynardo AT
Field based evaluation

**Mean value**

**Sigma**

**CoV**

**SoS Post processing**
- „Plausibility at a glance“
- Absolute vs. relative importance
- Exact values are difficult to extract
  ➔ Export data back to OptiSlang

**Most sensitive inputs**

**Numerical noise**

**CoP total**
Results and outlook

Results:
- Distribute information within the company (EXCEL-Add-In)
- Quantify overall robustness
- Quantify safe operation envelope
- Deeper insight
  -> simplify future problems (optimization)
- Identify impossible challenges
- Better visualization

Outlook:
- Distribute information:
  Use MOP-DLL as container
- Improve efficiency:
  Data transfer
  Speed of calculation (CI, parallelism)
- Simplify workflows and systems
Summary

- Complex customer requirements can be met
- Some answers cannot be provided on scalar basis but on signal level
- From signal to field it is just a small step
- Field data provides great overview
- Export to OptiSlang leverages full potential

- Greater insight during the design process
- Easy distribution and visualization of statistical information
- Better product and customer satisfaction
Thank you for your attention! Questions?

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