Case Study: Testing

Validating Screw Pump Robustness under Aerated Oil Conditions

deepfluid

Validating Screw Pump Robustness under Aerated Oil Conditions

Direct optical air-in-oil measurement for cavitation analysis and design validation

Twin-screw pumps | Controlled air-in-oil testing | Reliability under cavitation-relevant conditions

Challenge

Recurring cavitation-related field failures

Approach

Controlled measurement at 0 and 4 Vol.% air

Impact

Evidence-based design validation

Case Study at a Glance

Challenge

A pump manufacturer faced cavitation-related field failures despite existing design countermeasures.

Approach

Different pump designs were tested under controlled air-in-oil conditions using direct optical measurement.

Result

The measurement showed how 4 Vol.% air shifted cavitation behavior and revealed which design path actually improved robustness.

Impact

The data helped avoid ineffective design changes, reduce trial-and-error and support evidence-based product validation.

Core message

Direct optical air-in-oil measurement turned cavitation risk from an uncertain field issue into a measurable engineering parameter.

Case Study | Field

Application Context & Challenge

Cavitation risk remained difficult to validate before field deployment

Application context

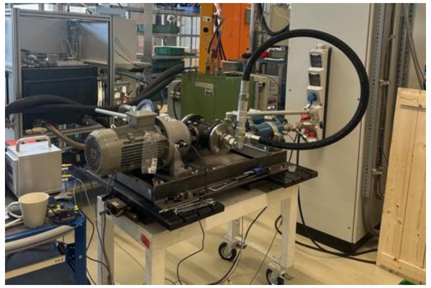
- Twin-screw pumps for lubricating oil supply in critical industrial applications
- Reliability, efficiency and uptime are essential
- Recurring cavitation-related issues were observed in the field

Existing design countermeasures

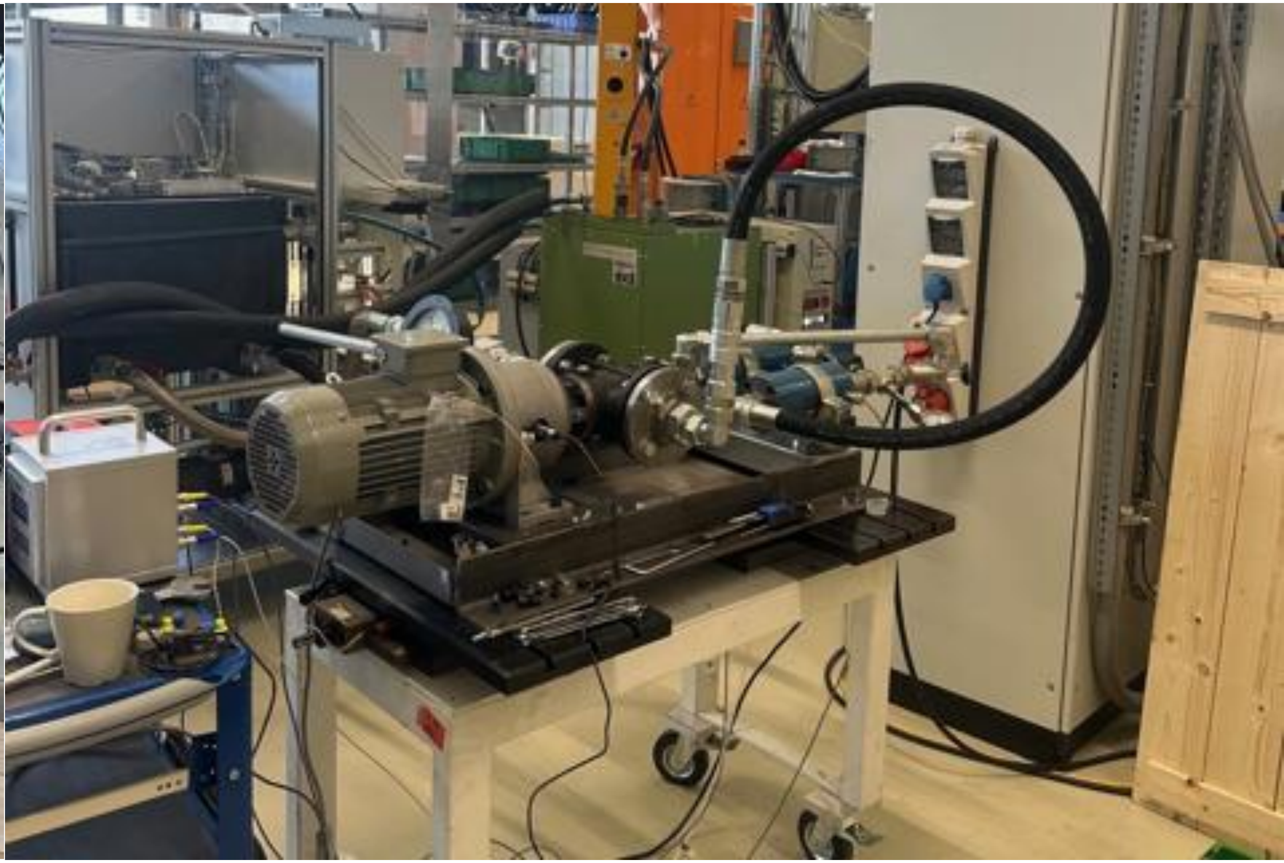
Design measure	Limitation
Cavitation bore drilling	Cost-effective, but not reliably validated before deployment
Spindle geometry regrinding	Higher-cost measure with uncertain functional improvement

Why this mattered

- Some optimization paths added cost without measurable benefit
- Design changes could fail after implementation
- The team lacked a reliable method to validate robustness under realistic air-in-oil conditions



Case objective: Create a controlled data basis to compare pump designs under defined air-in-oil conditions and identify which design path improves cavitation robustness.



Case Study | Testing

Measurement Approach

Controlled cavitation analysis under defined air-in-oil conditions

Field	Description
Measurement solution	Smart Bubble System / stationary measurement setup
Application	Twin-screw pump validation
Test focus	Cavitation behavior under aerated oil conditions
Air-in-oil condition	Controlled comparison at 0 and 4 Vol.% air
Method	Design of Experiments across pump designs and operating conditions

What was evaluated

- Cavitation onset under defined air-in-oil conditions
- Suction pressure behavior across design variants
- Functional performance of design countermeasures
- Comparative robustness of standard and optimized designs

Measured Metrics & Data Basis

From aerated oil conditions to measurable cavitation behavior

Metric	What it shows	Why it matters
Air content	Defined oil-air condition during the test	Creates comparable and repeatable test conditions
Suction pressure	Pressure level at which cavitation begins	Indicates cavitation robustness of the pump design
Cavitation onset	Operating point where cavitation becomes visible	Defines functional limits under aerated oil conditions
Design comparison	Baseline vs. optimization paths	Shows which design measure creates real improvement
Operating condition	Speed and test boundary conditions	Ensures differences are linked to design behavior

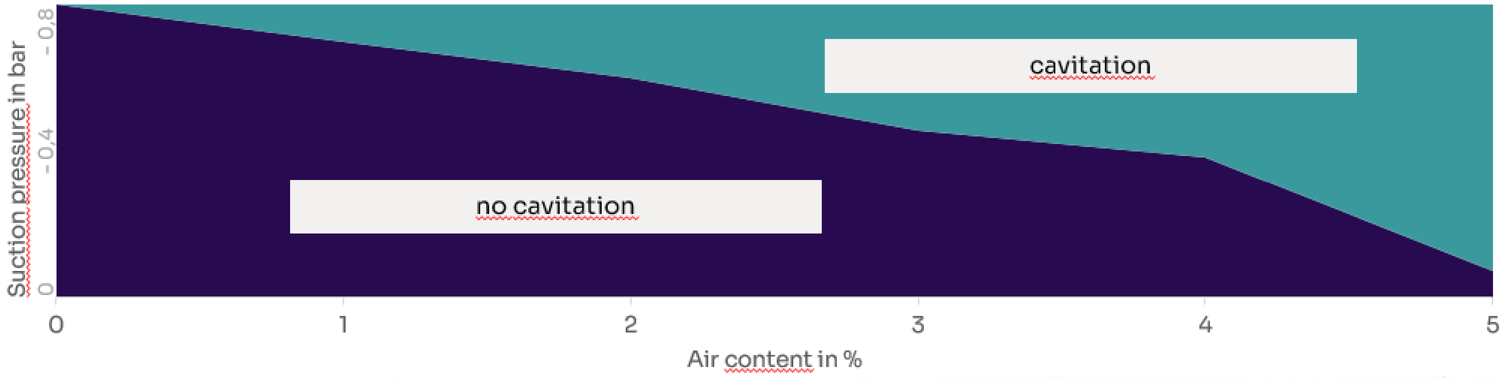
Data value: The measurement made it possible to compare pump designs under the same air-in-oil conditions and distinguish functional improvements from ineffective optimization measures.

Case Study | Testing

Key Results

Air content shifted cavitation behavior and exposed weak design paths

	Current/Standard Pump Design (2500 1/min)	**Construction Optimization: Design Path 1** (2500 1/min)	**Construction Optimization: Design Path 2** (2500 1/min)
Start of Cavitation **with 0% Air (Vol.%)**	-0,8 mbar	-0,9 mbar	-0,9 mbar
Start of Cavitation **with 4% Air (Vol.%)**	-0,3 mbar	**-0,35 mbar**	**-0,6 mbar**
Results		Cheaper Design Optimization Path does not work at all	Cheaper Design Optimization Path does work better, but not as good as expected



Cavitation occurred earlier when 4 Vol.% air was present.

The standard design showed reduced suction capability under aerated conditions.

Design Path 1 did not improve cavitation performance.

Design Path 2 performed better, but less than expected.

Key insight: 4 Vol.% air shifted cavitation onset across all designs and exposed ineffective optimization measures.

deepfluid

Engineering Interpretation & Impact

Measurement turned trial–and-error into evidence-based design validation

What the data showed

- Air-in-oil must be considered as a relevant validation condition
- The low-cost optimization path did not create measurable functional benefit
- The higher-cost optimization path improved behavior, but less than expected
- Functional thresholds became measurable and comparable

Value created

Development	Faster validation and reduced trial-and-error
Cost	Avoidance of ineffective or overly expensive optimization measures
Reliability	Better understanding of cavitation risk under aerated oil conditions
Customer confidence	Evidence-based validation for critical applications
Product robustness	Clearer design limits for future development

By making aerated oil behavior measurable, the team could identify which **design changes** were **truly effective** — and which ones **should be avoided** before costly field deployment.

deepfluid

Conclusion & Next Step

From uncertain field failure to measurable design evidence

1. **Air-in-oil changes pump behavior**

   Even moderate air content can shift cavitation onset and reduce suction capability.

2. **Design measures need measurable validation**

   Not every optimization path creates functional improvement under aerated conditions.

3. **Controlled air-in-oil testing improves development decisions**

   Comparable measurement conditions help reduce trial-and-error.

4. **Bubble-level measurement creates engineering confidence**

   Real measurement data supports more robust product validation and communication.