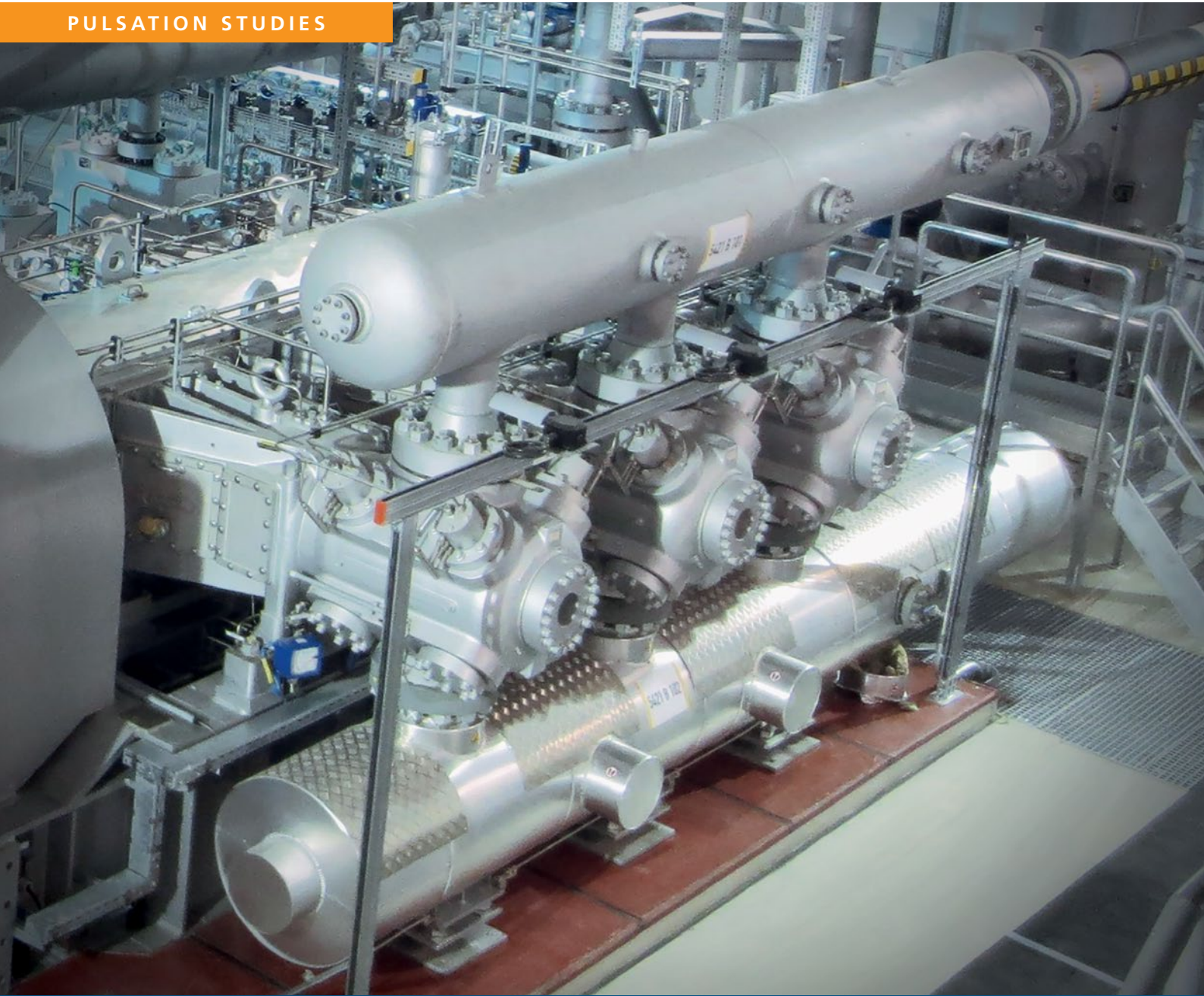


Looking at the big picture.



PULSATION STUDIES



Stop vibrations
at the source.



Being well prepared is not enough. It needs to be perfect!

The human heart may beat at a steady rate, for example when sleeping. Your heart will start racing when your reciprocating pump is having trouble and is pulsating like mad. You do not want that - and for good reason.

Small pulsations can easily become excessive, affecting reciprocating compressors or pumps. However, they can also spread to the foundation, the piping system or to valves or fittings. This can lead to leaks or even equipment damage.

Fortunately, vibrations and pulsations can be reduced or completely avoided. With a pulsation study from KÖTTER Consulting Engineers you can avoid excess pulsation and vibration at the project planning stage. This means that you have time to look forward to better things, like a pulse of 70 beats per minute – good for the peace of mind of any engineer.

Our services in detail for your planning reliability.

A pulsation analysis from KÖTTER Consulting Engineers is not just designed with pipes in mind, but goes much deeper. This is because complex compression equipment is subject to many different variables which need to be examined comprehensively.

Therefore, we inspect all mechanisms that cause pulsation and amplification. We look at the flow through pipe branches and valves. We consider vortex shedding and its effects on the piping system. We always get things flowing in the right direction, for example, by fitting optimised pulsation dampers, or by changing the piping layout. Be happy and don't worry either during the planning phase or beyond; you will not miss a beat when it matters.

- Studies pursuant to API 618 (reciprocating compressors), API 674 (reciprocating pumps)
- Reliable results by calculating gas and fluid-induced vibration over time (adaptive method, non-linearity, etc.)
- Quick damper checks and checks on power unit loading
- Inspections of valve dynamics
- Structural dynamics calculations (over time) of the mechanical vibration and dynamic stresses on components (mechanical response) in the piping system
- Acoustic simulation of the installation after determining the relevant scope in agreement with the customer
- Optimisation of the support concept for the piping system and vessels
- Static pipe stress analyses and data reconciliation with the results from the structural dynamic calculation
- Advice during detail planning and implementation, e.g. for flow metering systems

Communication without boundaries: Succeeding together instead of being alone at sea.

One of the largest gas production platforms in the world can be found off the Australian shore. It is a prime example, which illustrates that technical understanding alone is no guarantee for a successful project. Whether you are a planner from South East Asia, an Australian operator, a European machinery manufacturer, or someone else: If seamless communication between all participants fails, a project can start tottering. The same way that pulses and vibrations disrupt pipe networks.

We want to make sure that your project is successful, and we see ourselves as an independent mediator between all participants. For us that means "looking at the big picture". We take a technical view based on our know-how of all important performance areas. We can organise across international borders, applying our communication and culture specific expertise acquired over decades.





Your advantages: Expect a lot and get even more.

- You can plan your project with the highest degree of certainty
- You can expect us to provide practical solutions
- You can rely on your project being implemented on time
- The advice we provide you is independent of any manufacturer
- You will avoid possible damage to connected installations (e.g. pipe networks, foundations, valves and fittings, etc.)
- A pulsation study performed by us will create optimum conditions for both the performance and life of your machinery.

Our self-developed simulation software: Analysis you can trust.

What you develop yourself you understand best. This applies to software as well.

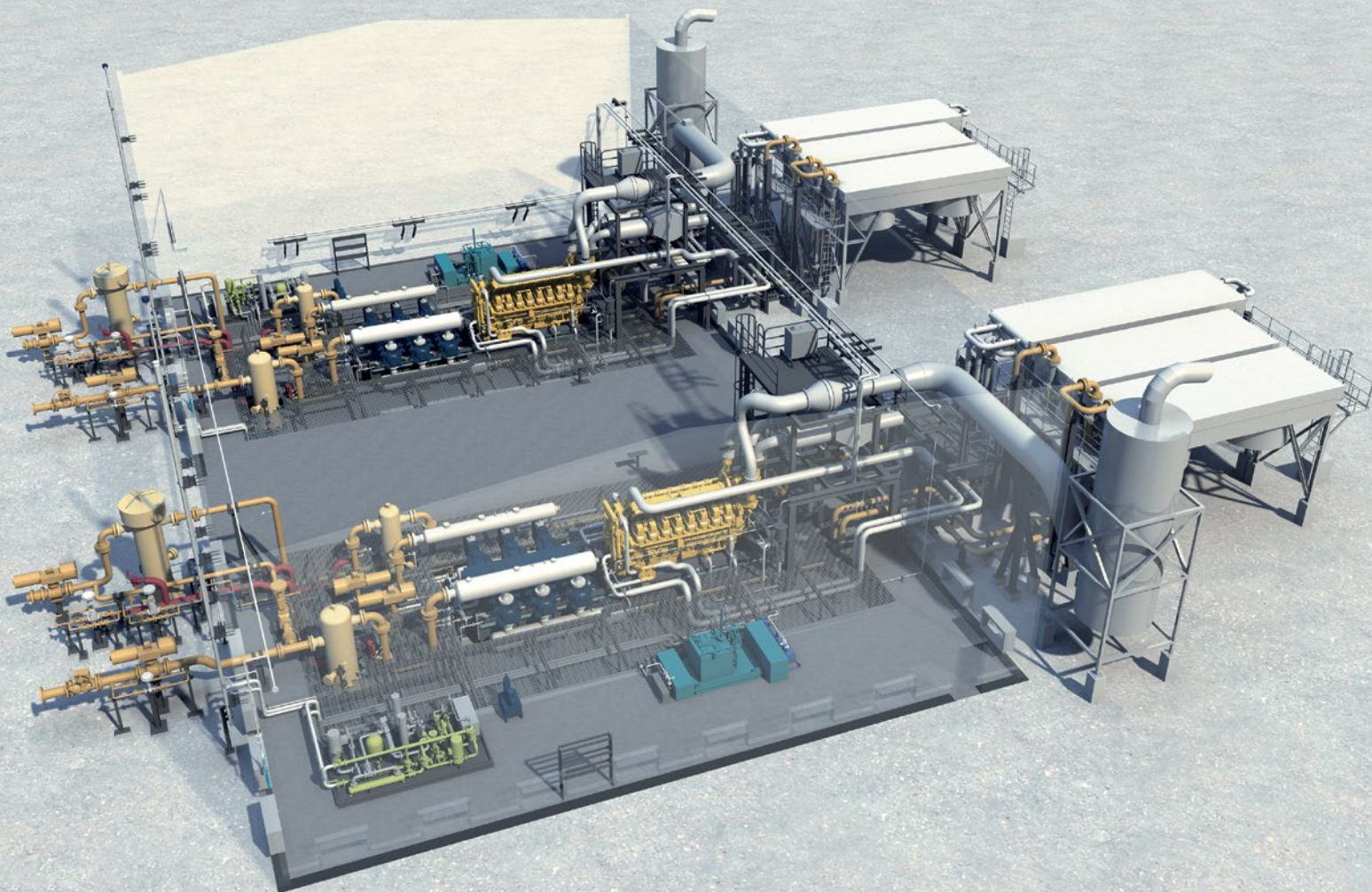
It was for these reasons that, during the 1990s, we designed, programmed and updated the software we use for pulsation studies. Since we did this ourselves, it allows us maximum flexibility.

The result is software that precisely meets our requirements. For example, it allows us to concentrate on the solution process without having to focus on the handling of whatever software.

Our customers are our best ambassadors. We say: Thank you for your confidence!

Here are some names:

- | | |
|--|---|
| ■ AIR LIQUIDE Deutschland GmbH | ■ Open Grid Europe GmbH |
| ■ BASSELL Polyolefine GmbH | ■ PCK Raffinerie GmbH |
| ■ Borealis Agrolinz Melamine | ■ PSE Engineering GmbH |
| ■ Borsig ZM Compression GmbH | ■ RWE Gasspeicher GmbH |
| ■ DEA Deutsche Erdoel AG | ■ Sasol Germany GmbH |
| ■ Dow Olefinverbund GmbH | ■ SIAD Macchine Impianti |
| ■ INEOS Köln GmbH | ■ TGE Marine |
| ■ Krytem GmbH | ■ thyssenkrupp Industrial Solutions AG |
| ■ Linde AG | ■ TOTAL Raffinerie Mitteldeutschland GmbH |
| ■ NEUMAN & ESSER Deutschland GmbH & Co. KG | ■ URACA GmbH & Co. KG |
| ■ Nynas GmbH & Co. KG | ■ Wepuko Pahnke GmbH |
| ■ ONTRAS Gastransport GmbH | |



Our qualifications: We are what you should come to expect.

- Since 1997, we have organised the annual "Workshop Kolbenverdichter" (Reciprocating Compressor Workshop), the German language communication platform for operators, manufacturers and scientists active in the field of reciprocating compressors.
- We are an active contributor to the EFRC, the European communication platform for operators, manufacturers and scientists active in the field of reciprocating compressors.
- We are internationally recognised experts for vibration monitoring and diagnostics pursuant to the International Standard ISO 18436.
- We participate in working groups and committees, (selection):
 - DVGW-Working Committee „Sound Insulation of Gas Installations“
 - NALS „Measurement and Assessment of Machinery Vibration“
 - NALS B1 „Machinery Acoustics – Design of Low Noise Machinery and Plant“
 - NALS B2 AK1 „Noise Control in Flow Channels“
 - Working group „Noise of Wind Turbine Generators“
 - Working group „Road Traffic Noise Reducing Devices“ of CEN
 - Standards Committee of DIN on Building Construction (NABau)
 - Working group „ZTV-Lsw“ of the Research Association of the Federal German Ministry of Transport (Technical Guideline for the Design of Noise Barriers on Roads)
- We actively support the standardization work (selection):
 - VDI guideline 3720 „Low Noise Design“
 - DIN ISO 10816-8 „Evaluation of Machine Vibration by Measurements of Non-Rotating Parts – Part 8: Reciprocating Compressor Systems“
 - VDI guideline 3839 „Notes on the Measurement and Interpretation of the Vibration of Machinery“
 - VDI guideline 3842 „Vibration in Piping Systems“

The ultimate benchmark during reconstruction: Combining calculation and measurement.

Over their operating life, most installations are modified or adapted for different uses. For example, the composition of gas passing through a compressor installation may change, or the installation will be partly modified. Both affect the acoustic properties of the piping systems and therefore the function as a whole.

Not only do we perform pulsation studies at the outset, we also carry out additional measurements on existing installations. We are then able to include all important factors in our evaluation and recommendations, thereby supporting smooth operations in the long term.





Looking at the big picture: Keeping everything in focus.

Instead of looking for a quick solution, we first identify where the problem lies. The root cause of a problem is not always located in the place where the symptoms appear. Acoustic or vibration effects are subject to interaction and amplification that may lead to interdisciplinary problems. We take a comprehensive approach, using skills that cover the full spectrum of sound and vibration engineering.

- We are interdisciplinary experts for almost everything measurable, from noise and structural vibration and pressure pulses
- We are able to measure dynamic processes up to 100 channels simultaneously
- We use contactless radio telemetry for our measurements
- We analyse material stresses with the aid of a "mobile" strain gauge system, specially developed by KÖTTER Consulting Engineers
- We use state-of-the-art technical measuring equipment
- We are KÖTTER Consulting Engineers!

Unbeaten know-how in pulsation problems, and unmatched expertise in eight disciplines.

Our experience and know how cover the full spectrum of sound and vibration engineering:

- Machine Dynamics
- Fluid Mechanics
- Pulsation Studies
- Technical Acoustics
- Shocks and Vibration
- Wind Energy
- Immission Control
- Building Physics

At last there is a way to calm your heart beat: Calling us!

Our pulsation studies convert theoretical considerations into real solutions that can be practically implemented. Contact our experts for your pulsation study.

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