MÜLLER-BBM

Consulting · Engineering · Measurements · Simulations · Testing · Troubleshooting

Vibrations in industrial plants

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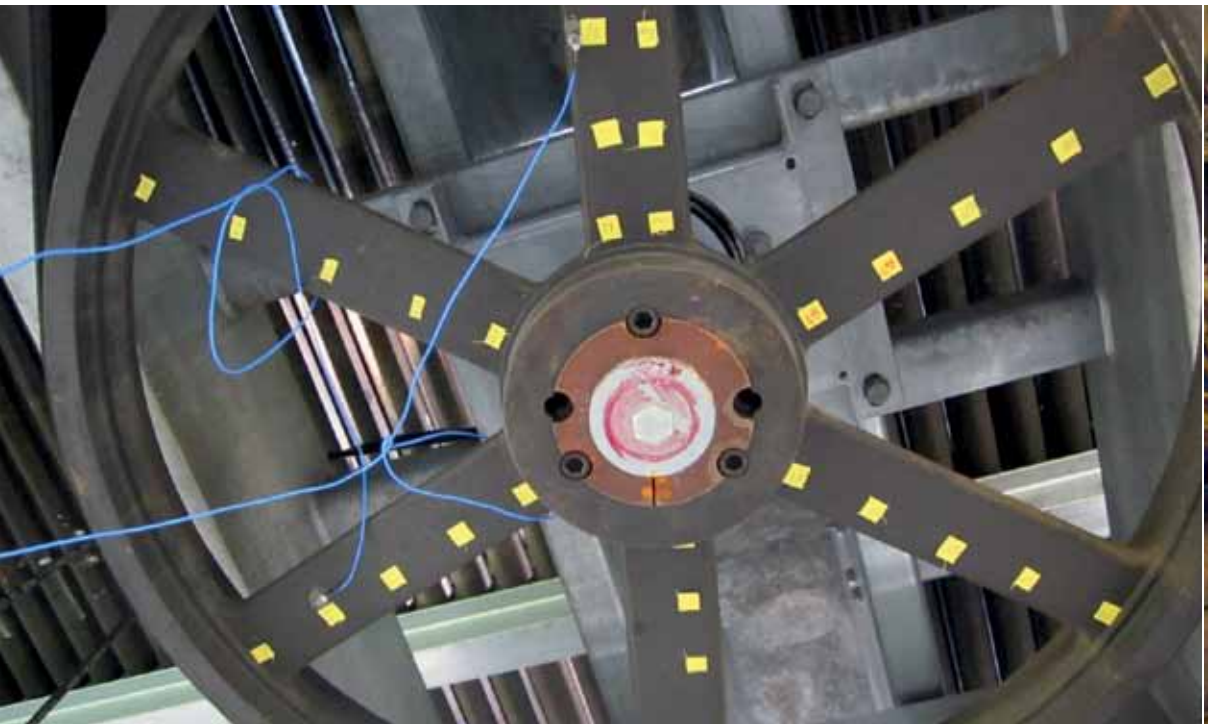
Vibrations in industrial plants

From the detection of a problem to its solution: With predictions, measurements, analyses and individual planning solutions, Müller-BBM consults and supports plant manufacturers, suppliers, and operators.



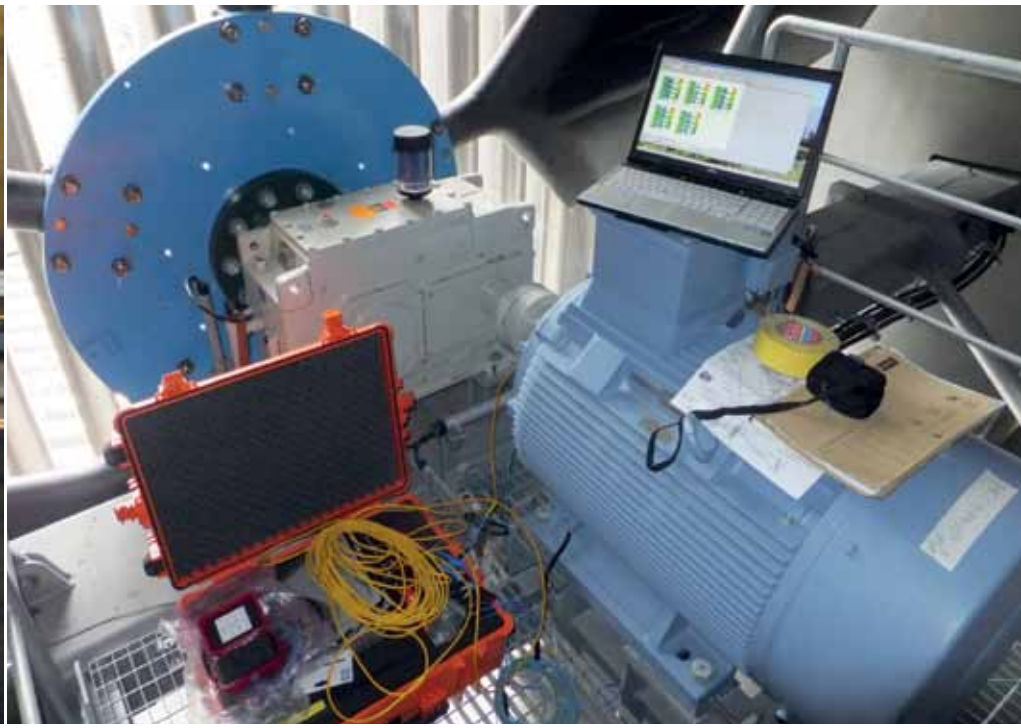
Unwanted vibrations in industrial plants affect not only operation processes and the plant's availability and safety – possibly resulting in a reduced service life. Malfunctions range from interfering noise to restricted production, hazards or damages that could make a non-scheduled plant shutdown inevitable. This issue concerns virtually all industrial sectors: from petro-chemical plants and chemical industry over power plants, wind turbines or off-shore parks, iron, steel or aluminum industries, the mining sector, waste industry, timber industry, the papermaking or glass production, building material production, automotive or rail vehicle companies to the mechanical or plant engineering industry.

Often, vibration problems occur when new plants are put into operation or when existing plants are modified. There are a multitude of causes: Increased capacities or performance optimisation can be blamed for unwanted vibrations, as well as unfavourable properties of particular components, such as shape, size, layout or material.

Typical examples for vibration-prone systems are compressors, pumps and valves, with their corresponding duct systems, as well as turbines, engines, steam boilers and other heat exchangers or combustion systems.

Smoothness

When commissioning a 800 MW coal-fired power station, the bearing vibrations at the ID fans and at the fresh air fans with drive performances of more than 6 MW were measured and evaluated in accordance with the respective standards. By identifying the operational vibrations and the dynamic properties of the cooling tower's axial fans, it was proven that there is an adequate distance between the exciting frequencies from unbalances and blade flow and the installation's resonances. Thus, smooth operation can be guaranteed without undue stress on safety and service life. Smooth running without vibrations is indispensable for a reliable and trouble-free operation of high-performance fans.



Interdisciplinary team of experts

The good news: even complicated noise and vibration problems can be solved. Müller-BBM's interdisciplinary team of experts can provide assistance with a holistic approach for the planning and dimensioning of new plant projects or troubleshooting in existing plants.

Within their industry sector our team of specialists and all-rounders has broad, technical know-how based on more than 50 years of experience in the control of industrial noise and vibrations. Our broad perspective ensures that we are also familiar with your daily business, such as operating sequences and procedural processes.

Customised solutions

Our experts excel at calculations, forecasts and vibration measurements. They manage temporary or permanent monitoring – in an objective and independent manner. They analyse measurement results and give an interpretation, identify underlying problems in terms of severity and work out tailor-made solutions that are simultaneously efficient and effective.

In the case of unwanted vibrations, we develop and specify primary or secondary measures. The latter comprise resilient mountings, insulation measures and damping elements that mitigate noise and vibrations along the propagation paths.

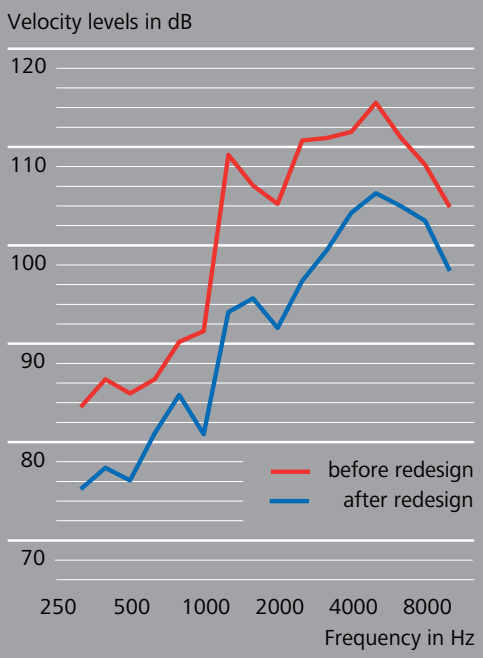
Time is precious – ideally, vibration protection should start right from the beginning of a new project. We encourage manufacturers of industrial plants and plant components to contact us in a very early planning stage.

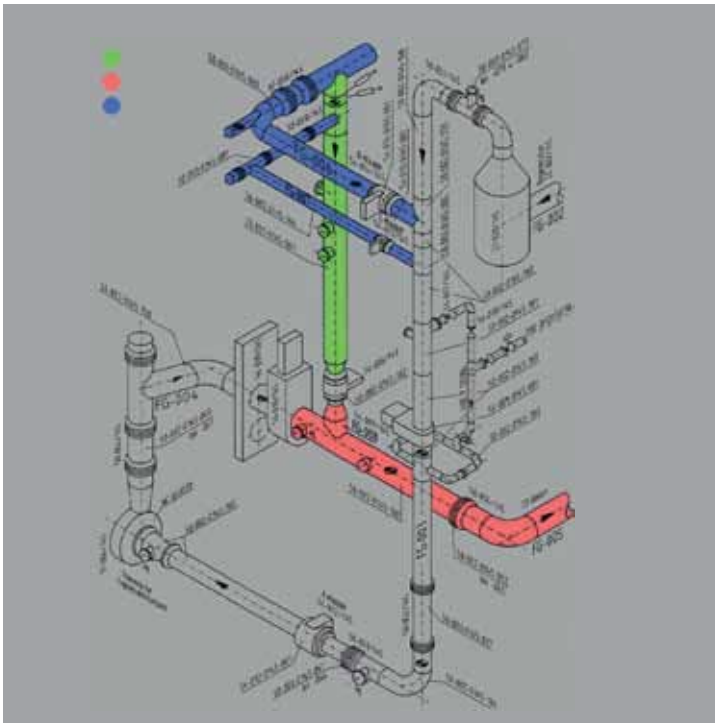
Duct inspections

During start-up and shut-down operations of a process steam boiler, damages occurred at the mounting brackets and at connected components. Contact-free measurements with a laser vibrometer at the duct (temperature 400 °C) let us identify high-frequency vibrations, induced by valve noises, as the cause of the problem. With a redesign of the starting valve overseen by Müller-BBM, the vibration velocity could be reduced by approximately three-quarters and thus down to harmless levels.

Flow optimisation

In the turbine of a petrochemical process unit, a control butterfly valve in the bypass line (> 750 °C) was damaged due to vibrations. In CFD simulations it was found that the flow conditions and – in particular – the velocity distribution at the valve and in the adjacent T-piece were unfavourable. Based on these findings the shape of the T-piece was optimised for a homogenisation of the flow conditions – an effective remedy for the defect.





Multi-faceted: methods, measurement techniques and tools

Our team always endeavours to offer only the methods and tools that fit best for your product or the unique situation in your plant – from computer engineering and measurement setup to technical solution approaches.

Processes and vibrations are measured, simulated and calculated by our experts. Furthermore, we determine the load spectra and make statements on the system's security and expected service life.

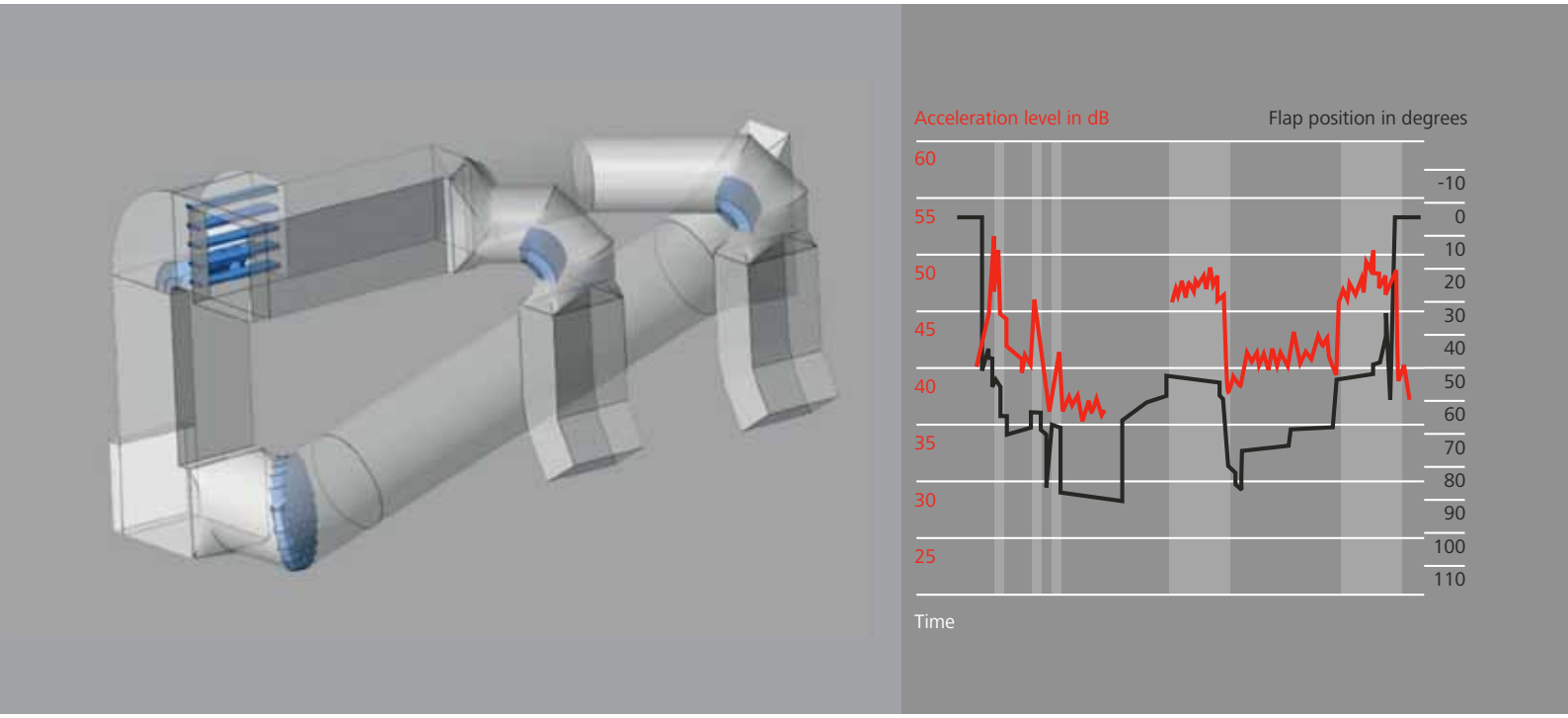
Our measuring devices and software tools are up-to-date, and our in-house test labs are equipped to meet practical requirements. Our test laboratory for sound and vibration, electromagnetic fields and light and our calibration laboratory for acceleration and acoustical parameters are accredited according to ISO/IEC17025.

Multi-channel measurements, experimental modal analysis, operational deflection shape analysis

Multi-channel measurement systems for vibrational investigations record dynamic data and analyse them in real time. We frequently use accelerometers, displacement transducers, pressure sensors, microphones, strain gauges and laser vibrometers. By means of multi-channel measurements we gather all the necessary data for assessing machine and equipment vibrations in one run. For clearly allocating a system's behaviour to an operating condition, potentially relevant operating parameters are recorded together with the vibration measurands.

Compensators damaged by vibrations

After starting up a new booster fan in the flue gas purification system of a coal power plant, massive damages occurred at the blast pressure side compensators of the existing ID fans. Multi-channel measurements of vibrations and pressure in and near the duct system showed that interaction between the existing ID fans and the new booster fan system led to low-frequency vibrations. These vibrations would quickly wreck the compensators whenever the flap position in the connection duct was between 50° and 70°. By a directed adaptation to the fan's operation mode, the vibrations could be reduced significantly and further damages could be avoided.



Modal analyses make use of defined external excitations to grasp a structure's elementary dynamic behaviour while determining natural frequencies, modal shapes and damping qualities.

The operational deflection shape analysis (ODS) investigates the vibrational behaviour of the object under test during operation. Phase accuracy in signal recording allows the presentation of vibrations at any frequency or load point. The animated visualisation of a plant's structural vibration facilitates the identification of causes for unwanted vibrations and the development of purposeful and effective remedies and optimisation measures.

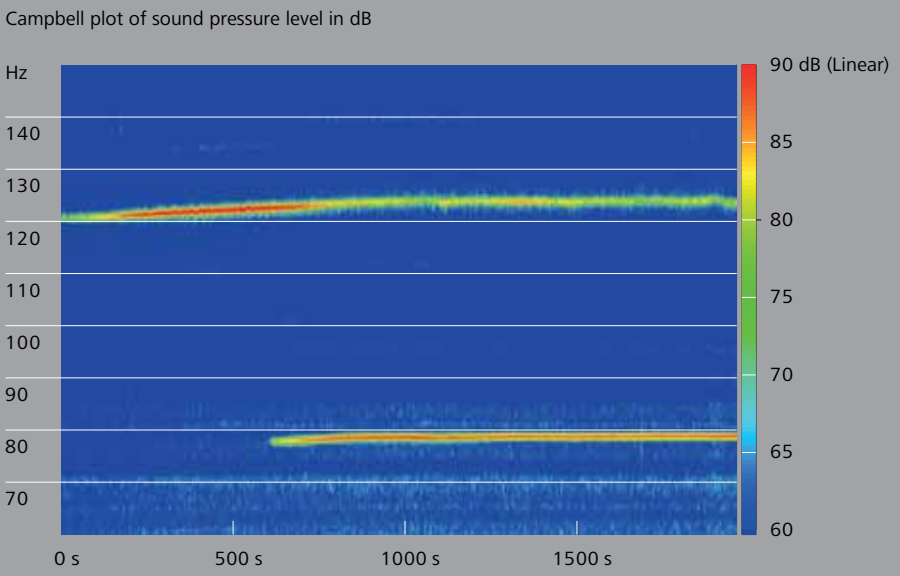
Special measurement techniques: for hot spots, inaccessible areas or severe cases

Hot, inaccessible, in motion, big, heavy? No problem for our special measurement techniques. For analysing systems at operating temperatures of up to approx. 800 °C we use high-temperature accelerometers or special strain gauges. At extreme temperatures or inaccessible measuring points we use non-contact laser Doppler vibrometers, for flow measurements we have developed special probes. For rotating components we use telemetric transmission of measured data.

For a reproducible and directed transmission of dynamic forces with very low frequencies into heavy or big structures and/or into the subsoil we have developed our imbalance exciter DYNAQ®. With its force- and frequency-controlled excitation, the dynamic stiffness of big constructions, such as entire buildings or the subsoil, can be determined. It is also possible to perform detailed investigations of the vibration transmission from one system to a neighbouring one. Then, conclusions can be drawn on unwanted resonance effects, on the soil-structure-interaction and on interfering effects of individual machines or machinery foundations.

Boiler hum

In a gas-fired steam boiler (combustion capacity 300 MW) unwanted hum noises and low-frequency vibrations were noticed in certain load ranges, caused by the interaction of periodic vortex sheddings at the heat exchanger ducts with the boiler's acoustic natural frequencies. With the aid of a specially designed procedure for measurement and evaluation, it was possible to identify the heat exchanger modules where the phenomenon occurred. Based on the measurement results and accompanying calculations, the boiler could be successfully detuned by purposeful fittings – thus ensuring that the resonance effect was suppressed and that the boiler could operate smoothly in the whole load range.



Measurement rig for the determination of the dynamic stiffness of resilient elements: tested vibration protection

To ensure the effectiveness of resilient decoupling elements (resilient mountings, insulations) as vibration protection measures, their dynamic properties in the relevant frequency range must be suited for the intended application. Dependable dimensioning parameters – if not given by the manufacturer – need to be defined with measurements under realistic preload conditions. With a special measurement rig, our specialists determine dynamic spring parameters depending on amplitudes, frequency ranges or static preloads. If needed, they provide support for the optimisation of decoupling elements.

Simulations: various tools for exact reference models

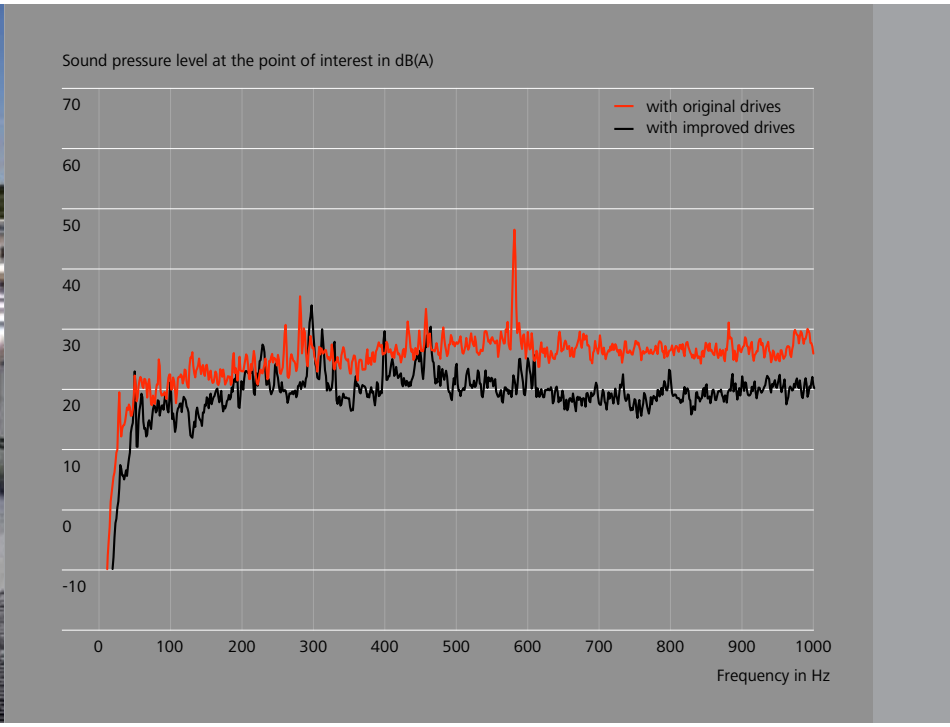
Be it a design study or the optimisation of a given design, resonance avoidance, the assessment of vibrations or fatigue checks – count on our support. Whether you require damage analysis, studies on alternatives in optimisation measures or the prediction of radiated sound energy – with our up-to-date tools for numerical simulations we can assist you in planning new plants or in making the best of existing ones, thus increasing their safety, service life and operating smoothness. By calibrating and validating the simulation models with measurement data, we come to exact reference models upon which a quick check of design variants can be done easily, followed by a reliable assessment.

FE-models, BEM, SEA and CFD

Finite element (FE-) calculations simulate the behaviour of machines and installations under dynamic loads, being an indispensable tool for their planning, dimensioning and design. Accurate in every detail, FE-models can be built up right from your CAD data. By means of updating software (FEMtools®), modal data from simulations can be correlated with measurement data. FE-models can be adapted to factual circumstances in a purposeful and realistic manner.

Noise emissions

Disturbing tonal sound emissions were observed at an air condenser. High-frequency vibrations of the inverter-fed fan drives were identified as the cause. The vibrations were radiated from the fan blades as well as from the air condenser's steel structure. By a combination of measures – comprising a modification of the operating states of both frequency converter and belt drive as well as the vibration-decoupled connection of the drives – the tonal noise components were reduced to approx. a tenth of their original level. Eventually, the subjectively disruptive impact was eliminated.



By means of the boundary element method (BEM), significant mechanisms of airborne sound radiation can be predicted. We use it whenever questions arise concerning the sound radiated by machines, plant components or casings.

Sometimes power input to a building component is due to dynamic excitation, implying the necessity to investigate higher frequencies. In this context, the high density of natural frequencies must be observed. Then, when it is no longer feasible to comprehend the structural behaviour from individual mode shapes, the time has come to use statistical energy analysis (SEA). This method features the investigation of the energy content of a building component as well as the average energy exchange between different components.

Computational Fluid Dynamics (CFD) is used to simulate flow processes and for the quantification of pressure, velocity, temperature and other flow characteristics. Anything that is difficult or impossible to measure may be calculated and visualised for any node point in a flow field in order to analyse duct flow and optimise it by means of variant analyses.

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Plant safety
Legally compliant business organization
Risk assessment
Chemical analysis

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Ship acoustics
Rail acoustics
Industrial acoustics
Machine acoustics and machine dynamics
Psychoacoustics
Mobile communication

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Consulting · Planning · Measuring Expert Opinion · Research

Müller-BBM Industry Solutions GmbH is a subsidiary of Müller-BBM AG, with headquarters in Planegg near Munich. Since 1962 Müller-BBM has been advising clients nationally and internationally and is now one of the world's leading engineering firms. More than 300 highly qualified employees form an interdisciplinary team of scientists and engineers in the most diverse specialist fields. The company currently has twelve offices in Germany as well as a branch office in Austria.

Notifications

Müller-BBM Industry Solutions GmbH is notified as an expert authority in accordance with § 29 b of the German Federal Pollution Control Act (BImSchG). The notification comprises

- determining emissions and immissions of air pollutants, noise and vibration
- verifying the correct installation and function in addition to the calibration of continuous emission measurement systems (CEMS)
- checking combustion conditions

Accreditations

Our testing and calibration laboratories are accredited according to ISO/IEC 17025:

- Test laboratory for sound and vibration, electromagnetic fields and light, air pollution control, measurement of hazardous sustances
- Calibration laboratory for acceleration and acoustical quantities

Müller-BBM Industry Solutions GmbH has a significant number of employees with competency certificates that were awarded to them on an individual basis. They include publicly appointed and sworn experts, state-recognised experts and otherwise appointed and notified experts.

Detailed information on the scope of our accreditation, its international validity and the corresponding certificates can be found on http://www.muellerbbm.com/quality/.

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