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ROTATING MACHINERY
ENGINEERING SERVICES



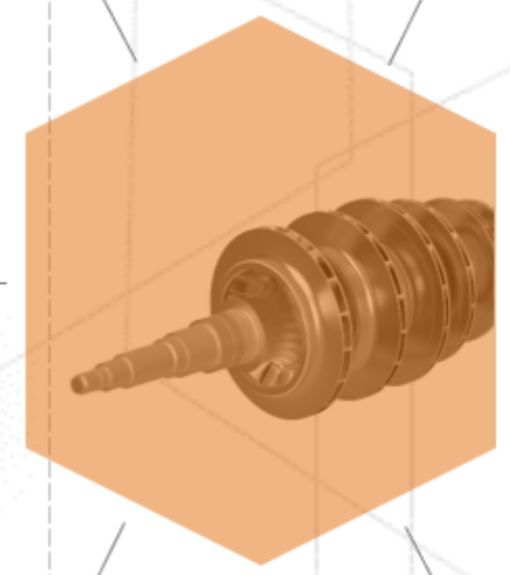
ROTATING MACHINERY ENGINEERING SERVICES

**UPGRADES &
MODERNIZATIONS**



**ENERGY SAVINGS
& RERATES**

**TROUBLESHOOTING
SPARE PARTS
REPAIRS**



**ROTATING
MACHINERY
DYNAMICS**

**CAD & REVERSE
ENGINEERING**

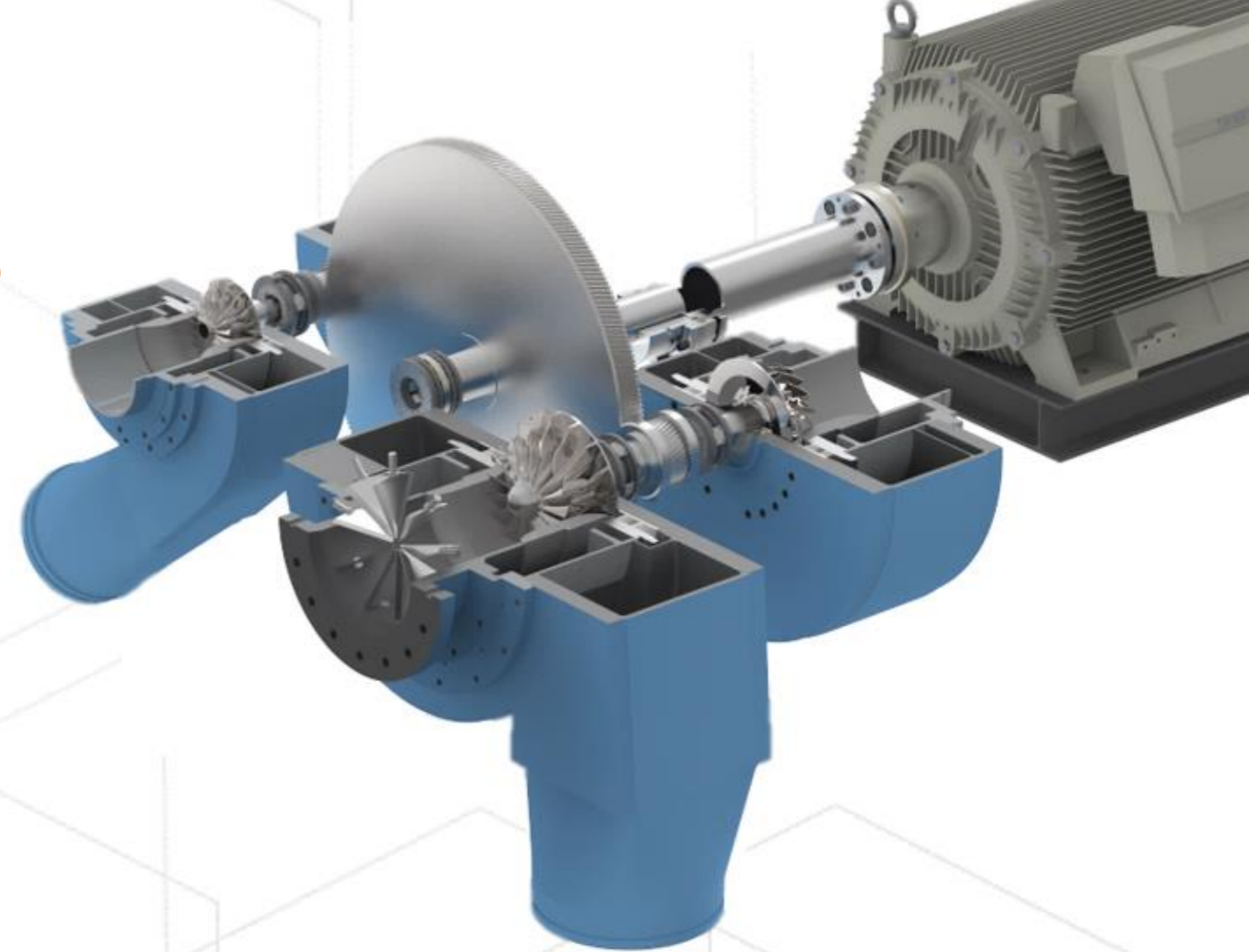


**RESEARCH &
DEVELOPMENT**

CENTRIFUGAL COMPRESSORS

For our clients we provide advanced engineering services in centrifugal compressors and blowers. We focus on industrial centrifugal compressors, based on API617–single shaft & integrally geared.

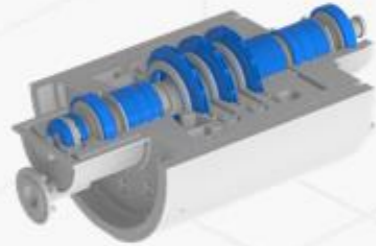
Repairs, troubleshooting, modernizations, revamps and rerates - we can provide complete solution from feasibility study and detailed design up to machine commissioning.



SERVICES

EXISTING MACHINERY

- Your centrifugal compressor is running well, but you want to know, if you could/should revamp it to achieve better operation parameters (higher efficiency, flow, pressure ratio).
- Your compressor is approaching general overhaul. You would consider a modernization on this occasion and you need to evaluate what are the benefits of various options.
- You want to operate the compressor with different gas parameters.



GREENFIELD PROJECTS

- You are planning to build new process plant and you need a support with compressor RFQ establishing.
- You work in EPC, which is preparing a new plant project, and you need a support with centrifugal compressor selection/design.
- You have received several compressor proposals and you need to compare and evaluate them.



- Feasibility and feed studies – technical, return on investment...
- Basic & detail design
- Troubleshooting
- Support with compressor tenders
- Evaluation of OEMs proposals
- Compressor concept & detailed design (single shaft & integrally geared)
- Thermodynamic design
- P&ID system basic design – gas, seals, oil, machine monitoring system
- Upgrades – impellers, seals, bearings, couplings...
- Rotor dynamics, vibration (calculation, analyze, evaluation)
- Compressor and gearbox mechanical loss predictions, gear rating
- Research & development
- Centrifugal compressors trainings, education

CENTRIFUGAL COMPRESSOR REVAMPS & ENERGY SAVINGS

Your older centrifugal compressor can be often modernized to provide considerable power savings. We offer complete support from initial feasibility study to complete life cycle support.

IMPELLER UPGRADES

<10%
Power
saving

Centrifugal compressor revamps/ rerates are typically revolving around impeller upgrades. On older compressors sometimes significant power savings can be achieved. Modern impellers are optimized with CAD/CAE and can be fitted to client gas specific parameters to deliver superior aerodynamic efficiencies.

VARIABLE SPEED OPERATION

<7%
Power
saving

Variable speed drive (VSD) operation brings possibility to significantly reduce the flow & pressure ratio (and adsorbed power) for partial load operation & turndown. Depending on compressor OEM design, flow/pressure increases in range of several percent are also possible by increased operating speeds.

INLET GUIDE VANES

<5%
Power
saving

Existing compressors can be upgraded with inlet guide vanes (IGV). IGV extend flow operating range flexibility, significantly reduce adsorbed power during off-design and partial-load operation. IGV upgrades are typically suitable for integrally geared compressors.

DIFFUSER GUIDE VANES

<4%
Power
saving

For compressors built with vaneless diffusers, adding diffuser vanes can improve efficiency for specified operating point. If compressor is operated on broader operating flow range, variable diffuser vanes can be designed and added to compressor control system (typically only available for integrally geared units).

DRIVER REPLACEMENTS

<3%
Power
saving

Replacing of aged electric motors with modern high efficiency motors can bring power savings in range of few percent.

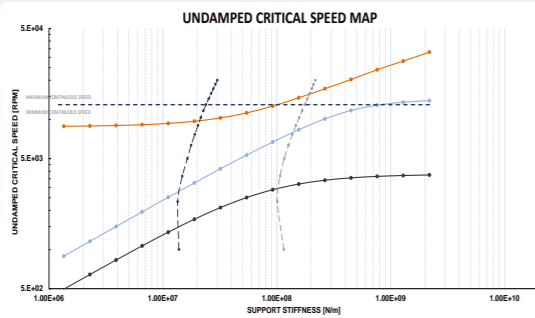
In recent years some older gas turbines are increasingly difficult to maintain. Replacements with VSD electric motors & frequency converters are often optimal solution.



ROTATING MACHINERY DYNAMICS

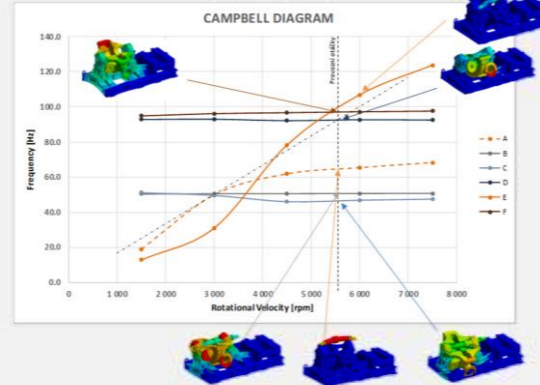
We perform lateral and torsional dynamics analysis of isolated rotors and complete drivetrains including bearing support structures, housings and frames. Undamped, damped analysis, damped unbalanced response, stability. We follow standards API 612/613/617/684 or according to customer standards.

Our analysis and calculations are based on many years of practical experience and in-house experimental research activities in field of rotor dynamics and rotating machinery.



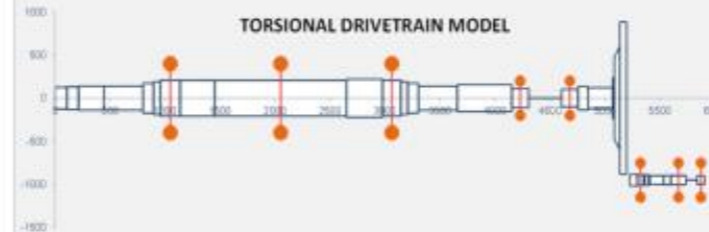
LATERAL ROTOR DYNAMICS

- According to API612/613/618/684 or to customer standard
- Isolated rotor or complete drivetrain analysis
- Vibration and instability suppressions
- Hydrodynamic and roller bearing dynamic properties approximation
- Eigen mode shapes and frequencies
- Damped unbalanced response analysis
- Stability analysis
- Campbell diagram
- Undamped critical speed map
- Bode diagrams
- Logarithmic decrement diagram



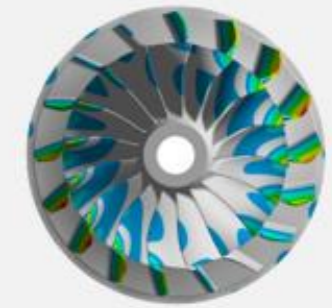
MACHINERY DYNAMICS NUMERICAL ANALYSIS

- FEM analysis (ANSYS Mechanical)
- Complex spatial dynamics evaluation
- Modelling and analysis of complete structures: rotor – bearings – frame
- Separate machines or complete drivetrain including coupling connections
- Modal analysis including damping and Coriolis effect, Campbell, Log-dec diagrams
- Harmonic analysis - damped unbalanced response, relative and absolute vibrations (displacement, speed, acceleration)



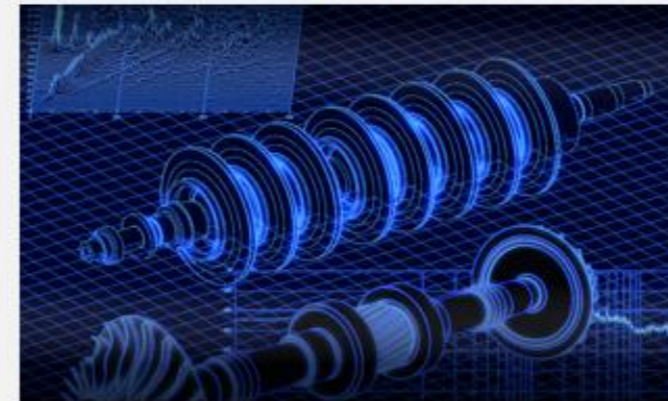
TORSIONAL ROTOR DYNAMICS

- According to API612/613/618/684 or to customer standard
- VFD (variable speed drive systems) analysis according to API standard
- Isolated rotor or complete drivetrain analysis
- Campbell diagram, mode shapes



IMPELLER DYNAMICS

- Cracks on impellers in service operation can be often caused by structural vibrations due to dynamic interaction between rotating and stationary parts.
- So called SAFE diagram (Singh's Advanced Frequency Evaluation) is a tool for assessing potential resonance of the impeller structure.



VIBRODIAGNOSTIC MEASUREMENT EVALUATION

- Machinery vibrations measurement evaluation and assessment, we specialize in relative rotor vibrations
- Rotor dynamics measurement and simulation identification
- Analysis of Bode diagram, orbit, frequency spectrum, etc.
- Recommendations, methodology and best-practice limits for low and high-speed rotor balancing
- Proposals and corrective actions to suppress vibration levels of existing rotating machinery
 - optimization of hydrodynamic bearing geometry
 - suppressing rotor instabilities (damper seals applications, etc.)



VIBROSTANDS AND R&D ACTIVITIES

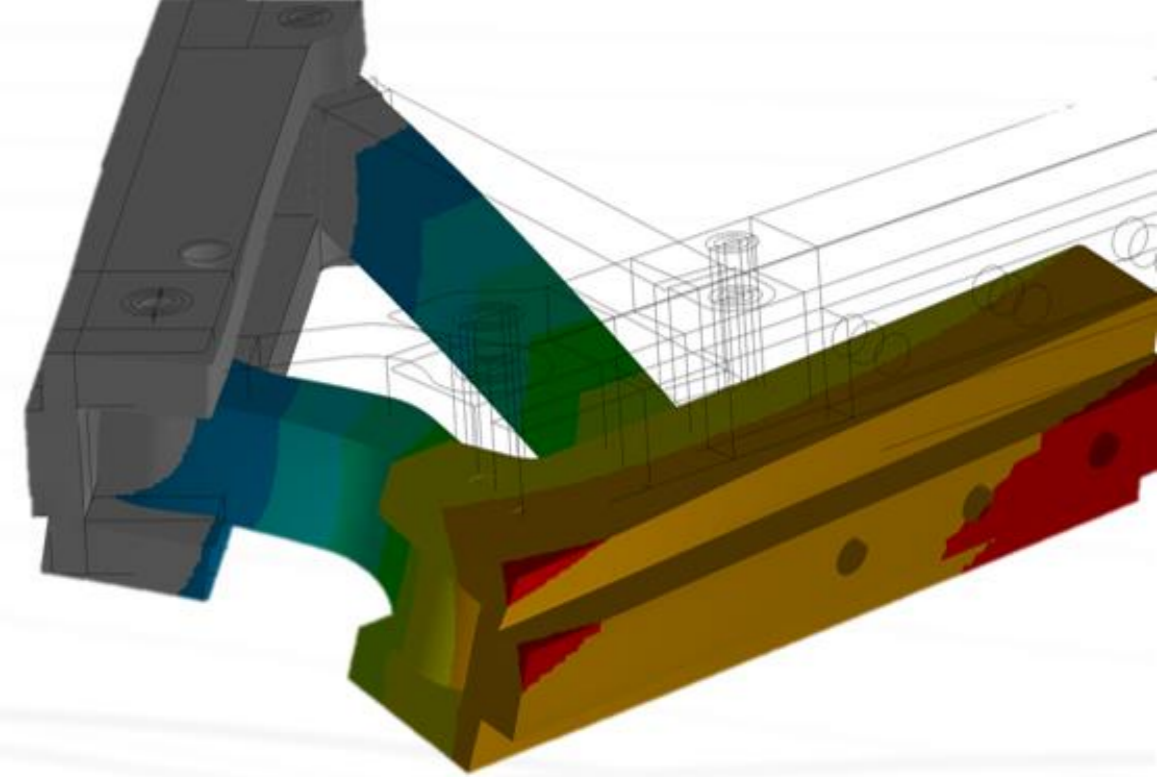
- RotMach design and in-house manufacture range of vibrostands.
- RotMach vibrostands offer an excellent, cost effective and safe tool to gain a hands-on experience with rotating machinery vibrations.
- Vibrodiagnostics and machinery personnel can be trained in rotor balancing and vibrations patterns associated to various component failures.
- Vibrostands can be also used for effective data generation for machine learning applications. Various kinds of machinery faults can be simulated in laboratory environment.

NUMERICAL SIMULATIONS

We provide structural analysis of rotating and nonrotating machinery in the ANSYS Mechanical environment. We specialize in dynamic modal and harmonic analysis related to rotating machinery vibrations.

We use solver ANSYS CFX to simulate fluid flow. Our field of expertise are especially calculations of centrifugal compressors but we also simulate other rotating and non-rotating machinery and equipment.

FEM
CFD

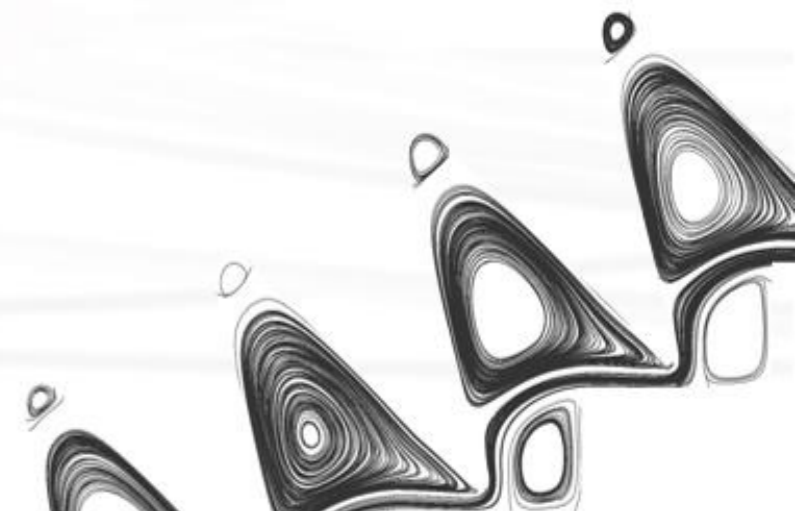
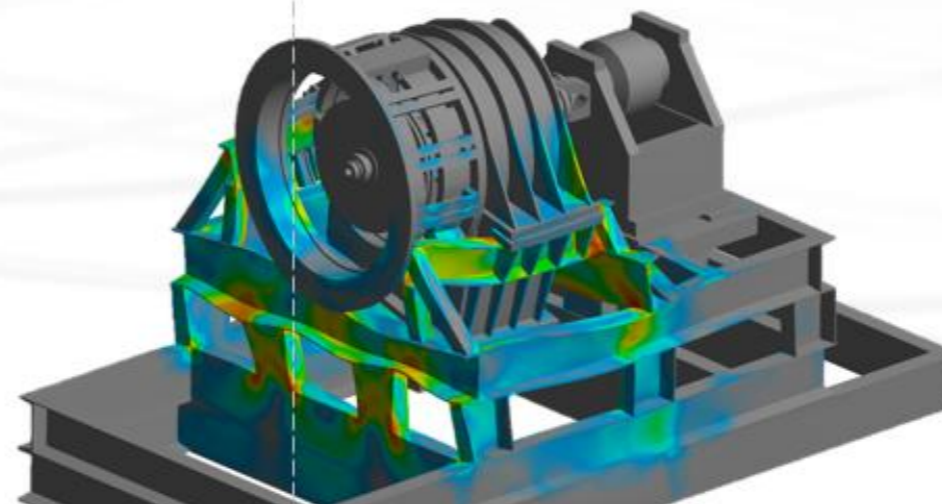
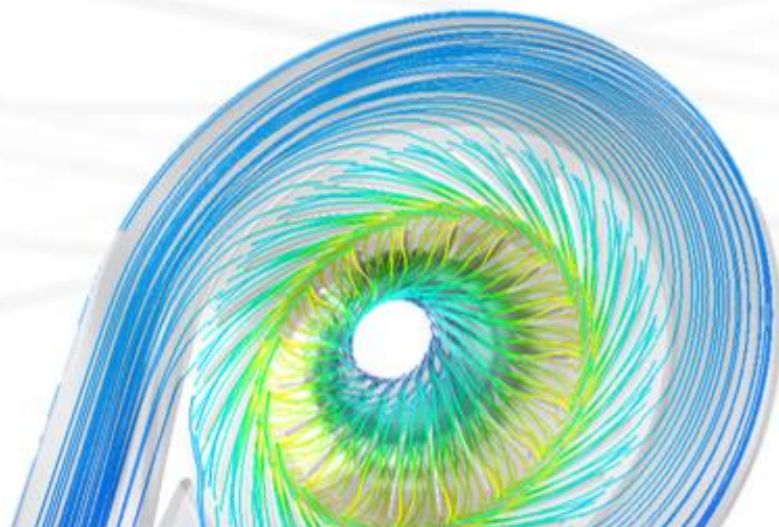


CFD SIMULATIONS

- Calculation of machine operating performance, stage's full characteristic curves for thermodynamic design (compressors, pumps...)
- Identification of critical regions, flow path optimization and pressure loss calculation
- Development of a new design or flow path upgrade for existing machines
- Ideal or real gas properties
- Steady-state and transient simulations

FEM STRUCTURAL SIMULATIONS

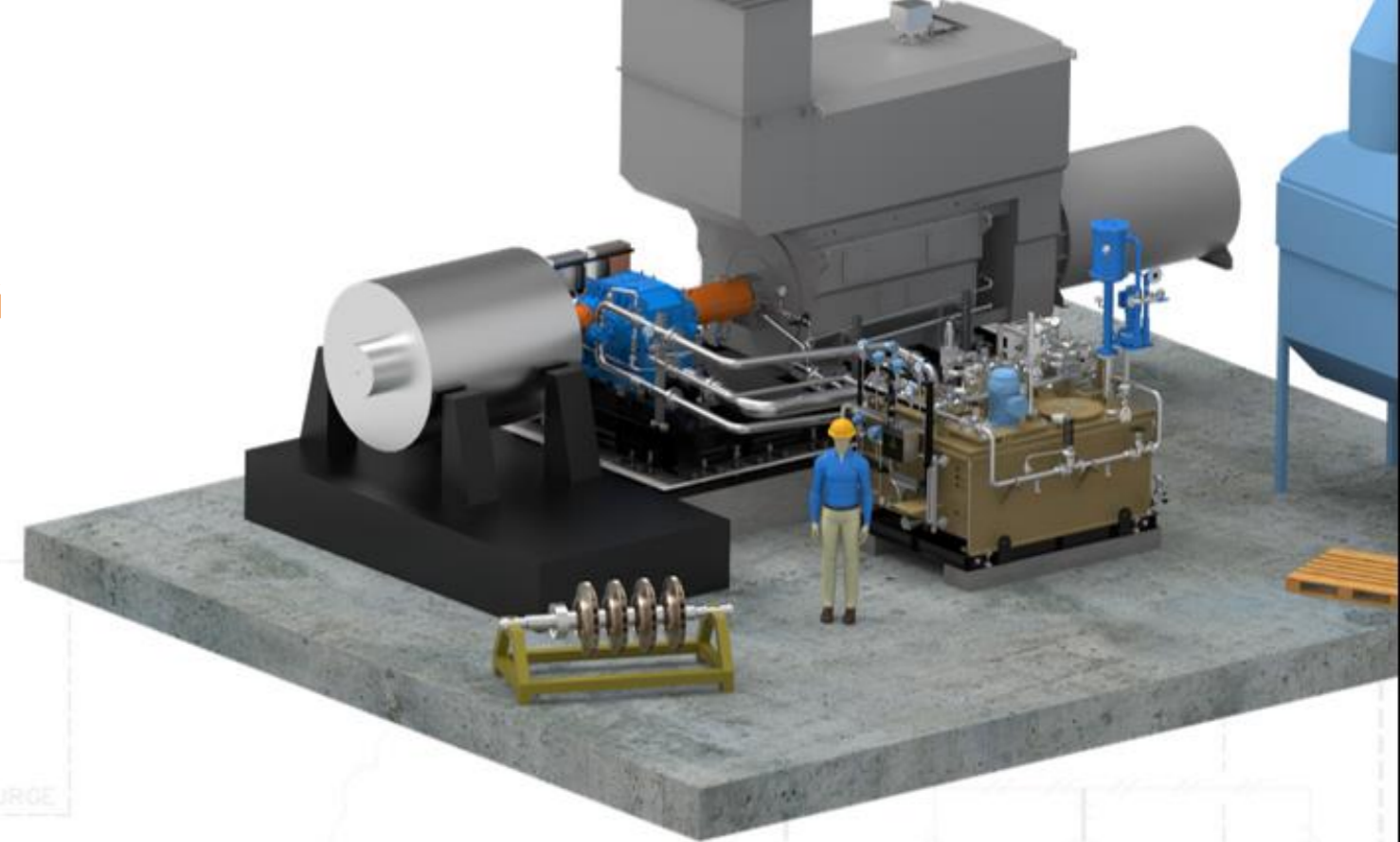
- **Static linear and nonlinear analysis of rotating and nonrotating structures and assemblies**
- Impeller design verification including material's plasticity region
- Foundation stiffnesses for the rotordynamics analysis, machine housing and frame optimization
- Contact analysis, complex mechanisms and other simulations
- **Dynamic analysis of machines and drivetrains, including damping**
- Modal and harmonic response
- Machines calculation including casing, foundation, etc.
- Dynamic matrix approximation for both roller and hydrodynamic bearings
- Campbell and Bode diagram, stability



CAD DESIGN & ENGINEERING

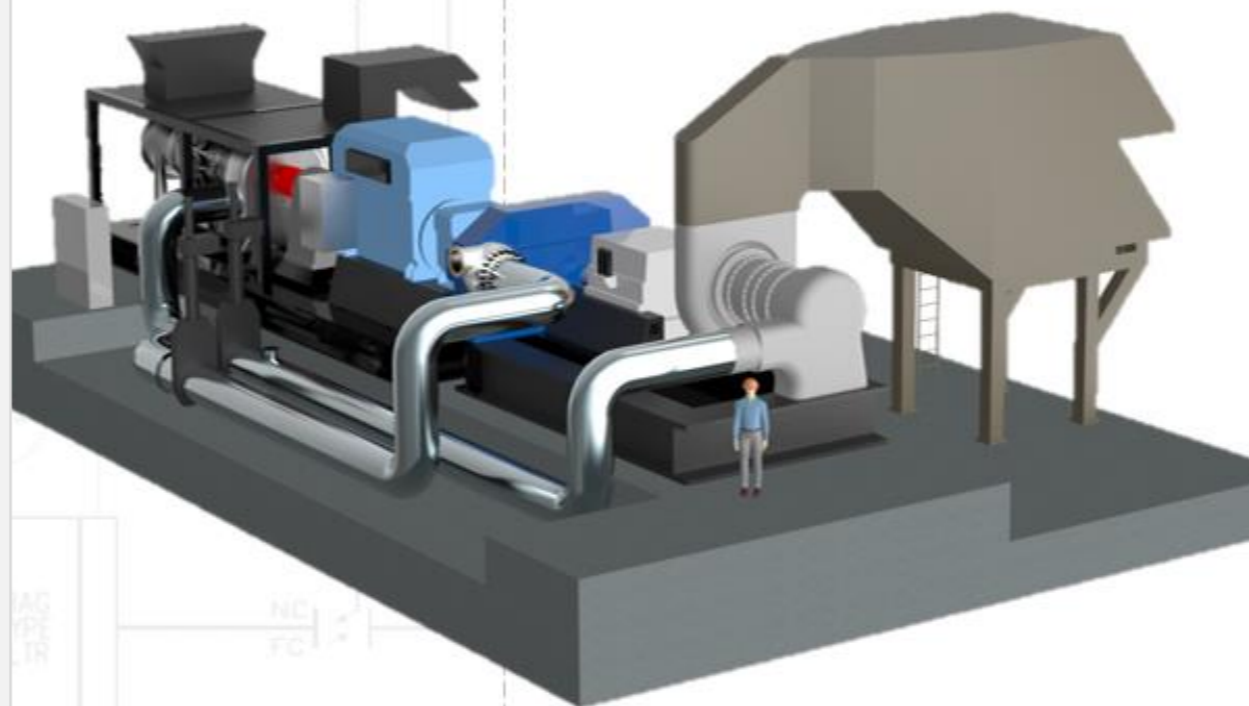
For projects involving machinery repairs, upgrades or new build units we can offer CAD & engineering services for both individual parts and assemblies. We design new parts or can ensure reverse engineering including parts 3D scanning.

We provide also solutions for an integration of centrifugal compressors and other rotating machinery with corresponding accessories into new/existing technology process.



ENGINEERING SERVICES FOR CENTRIFUGAL COMPRESSOR PACKAGES

- Integration of centrifugal compressors and their accessories (vessels, valves, piping) into new/existing technology process
- Preparation of designing documentation for machine-technology part
- Supervision and participation at commissioning
- Calculation and design of industrial refrigeration loop with compressor unit (screw compressor, reciprocating, centrifugal). One or more evaporation isotherms, cascade, etc.



DESIGN SERVICES FOR CENTRIFUGAL COMPRESSORS

- We provide broad range of design and reverse engineering services for compressor components. We can handle all levels from initial concept, 2D/3D up to detailed manufacturing drawings:
- Compressor internal parts
- Base frames and skids
- Coupling guards
- Oil piping systems

METAL MATERIALS



We offer technical support and consulting for metal material selection for rotating machinery and related technologies. We provide practical know-how with the right choice of materials for corrosive and aggressive high or low temperatures environments.

We have experiences with non-ferrous material applications, such as titanium or nickel alloys.

MATERIAL SELECTION

- Material selection for specific applications
- Corrosion resistance in aggressive environments (H₂S, wet CO₂, H₂, etc.)
- Material design for:
 - High, low or cryogenic temperatures

MACHINE'S FAILURE ASSESSMENT

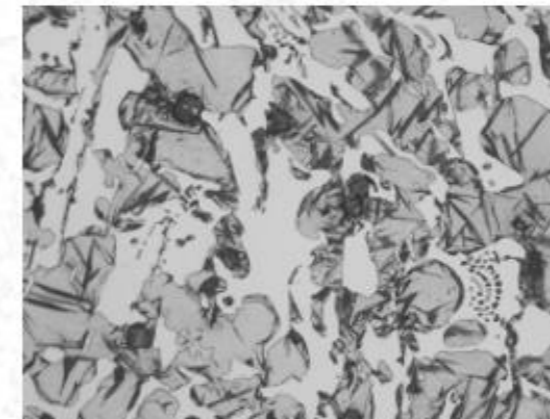
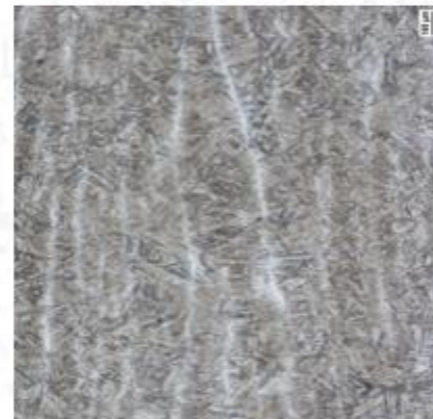
- Investigating machine failures associated with material failure caused by corrosive attack or poor quality of semi-product material
- Material corrosion loss
- Machine failure due to inadequate material mechanical properties

MATERIAL TESTS AND RESULTS EVALUATION

- Providing material tests in external certified laboratories
- Fractographic analysis
- Corrosion resistance tests in the autoclave
- Assessment of material quality based on the supplier's material attest
- Methodology for assessment of supplier material's quality

MATERIALS FOR ROTATING MACHINERY

- Recommendations for material selection of rotating machinery parts
- Material compliance to international standards API, ASTM, AMS, ČSN, EN, ISO
- Assessment selected materials suitability for the existing and new machinery
- Non-ferrous metal materials: titanium and nickel alloys, etc.



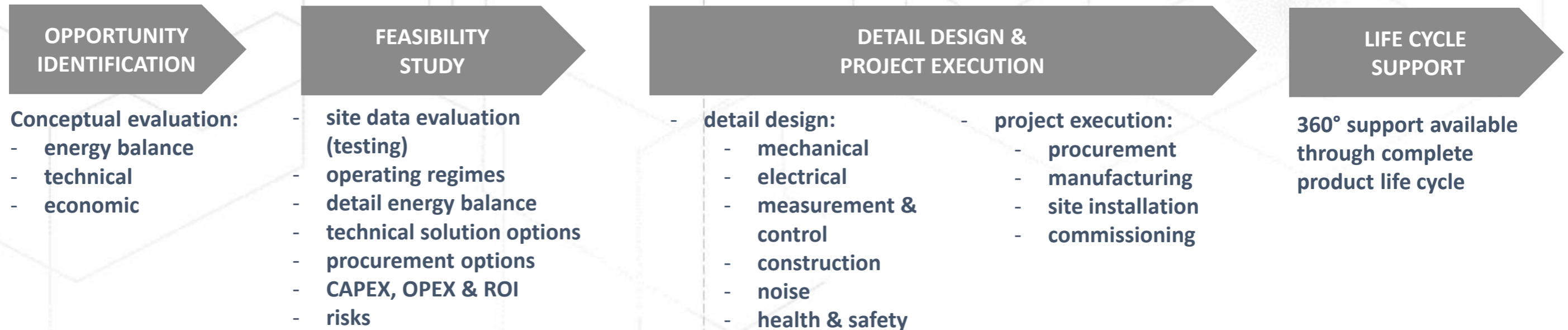
PRESSURE REDUCTION VALVE REPLACEMENTS

In various production processes steam pressure is reduced by reducing valves. Thermodynamic potential is lost without useful energy utilization. Reduction valves can be replaced by rotating expanders and turbines. Several types are readily market available:

- Screw type expanders
- Radial turbines
- Axial turbines

Choice of optimal machinery depends on site specific parameters such as steam temperature and pressures, ATEX requirements etc.

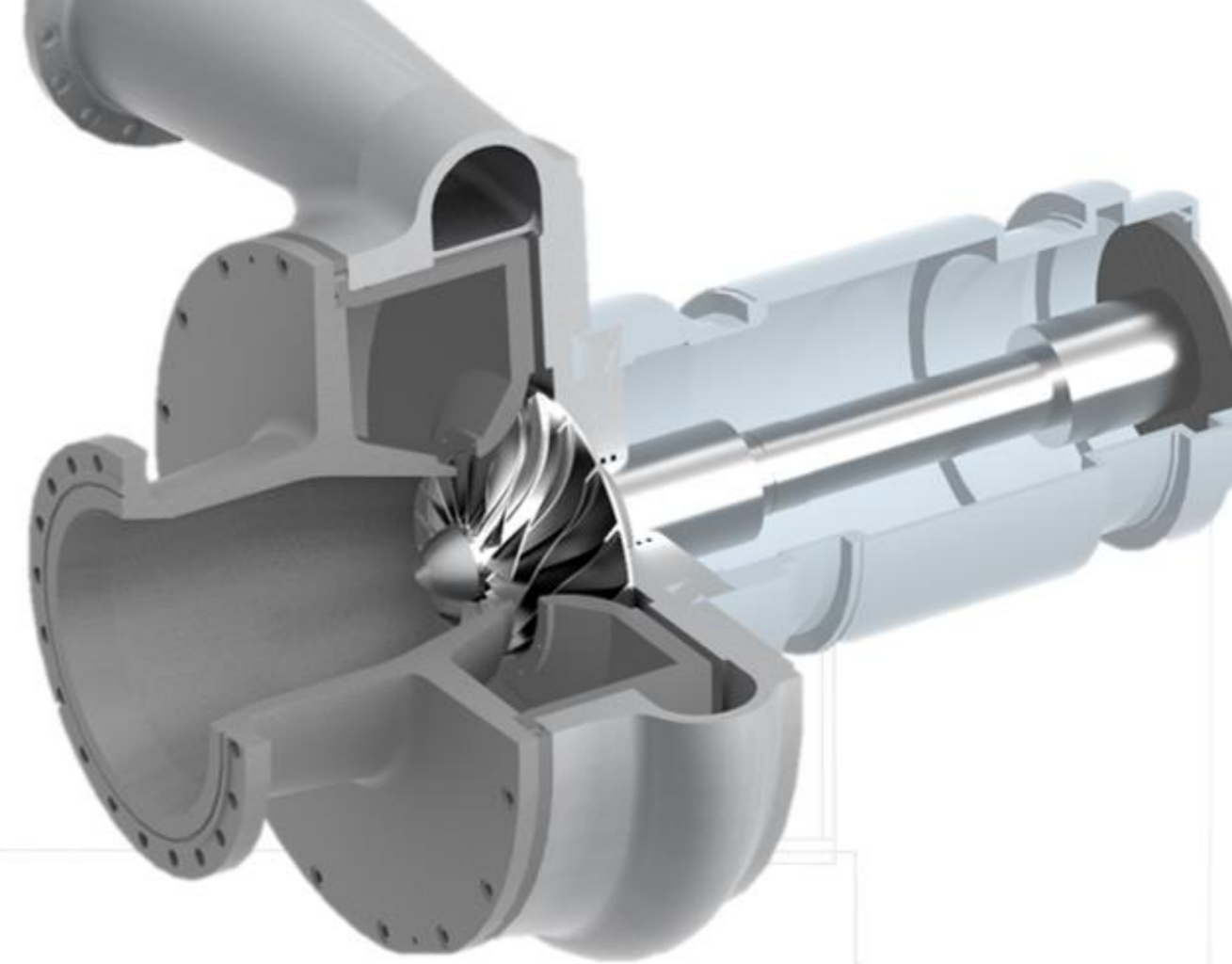
Together with our partner [Energetic](#) we offer complete support from opportunity identification to life cycle support.



EXPERIMENTAL HIGH-SPEED BLOWER WITH AERODYNAMIC BEARINGS

RotMach is equipped with experimental high-speed blower with integrated electric motor and rotor supported on aerodynamic bearings, 100% oil free solution.

This next generation design offers compact and low-cost base for a broad spectrum of R&D applications. We are offering capacity of the machine for research activities such as impeller validations etc.

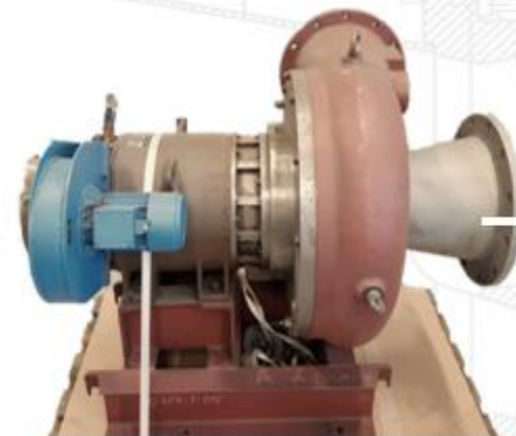


MAIN DESCRIPTION AND APPLICATION



BASIC PARAMETERS

- **EM power:** 100 kW
- **Max speed:** 18 260 RPM
- **Impeller:** 3D type
- **Impeller diam.:** 285 mm
- **Control:** VFD
- **Mass:** 1 000kg
- **Dimensions:** 1 200 x 1 100 x 1 000 mm



- One stage centrifugal blower with overhung impeller and cast volute, primarily for air compression
- High-speed asynchronous electric motor controlled by frequency converter (VSD)
- Impeller fitted directly on electric motor shaft
- Aerodynamic bearings:
 - radial with tilting pads
 - minimal frictional loss
 - removes using of an oil system(100% oil free solution)
- Machine offers relatively compact and low operating cost base for development of next generation turbomachinery. We are looking for a partner and we offer cooperation in R&D based on this technology, mainly in the following areas:
 - Design and validation of radial impellers and flow path, measurement and control of centrifugal compressors and blowers
 - Applications of aerodynamic or aerostatic bearings
 - Other related R&D challenges

CONTACT

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