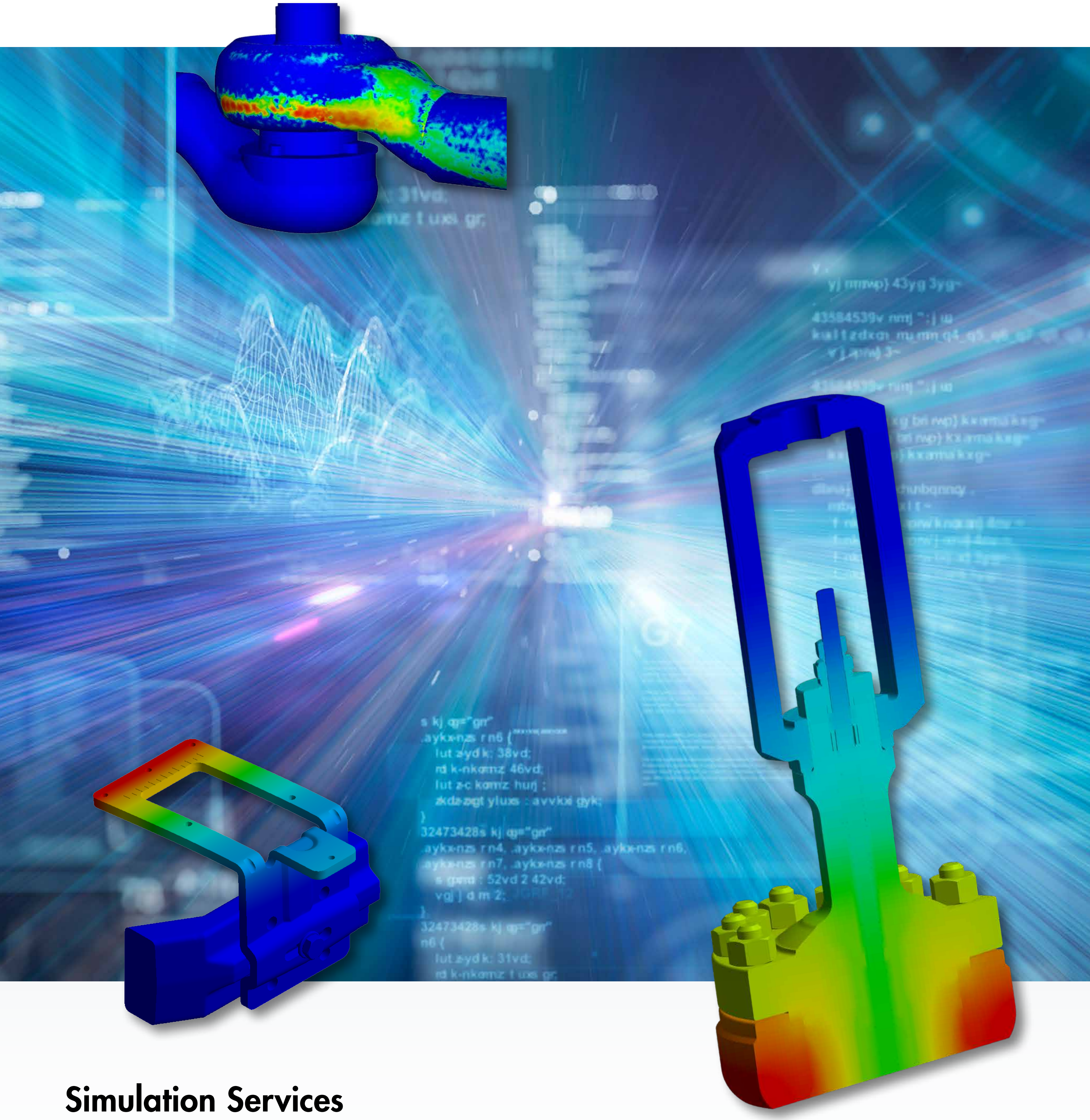
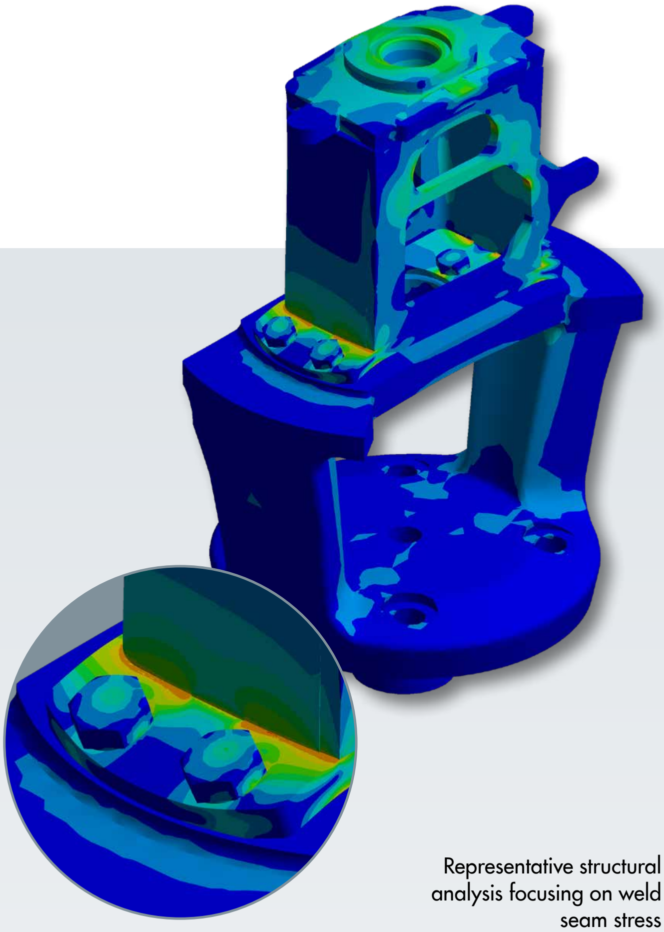
INNOVATIVE CONTROL TECHNOLOGY



Simulation Services

SMART IN FLOW CONTROL

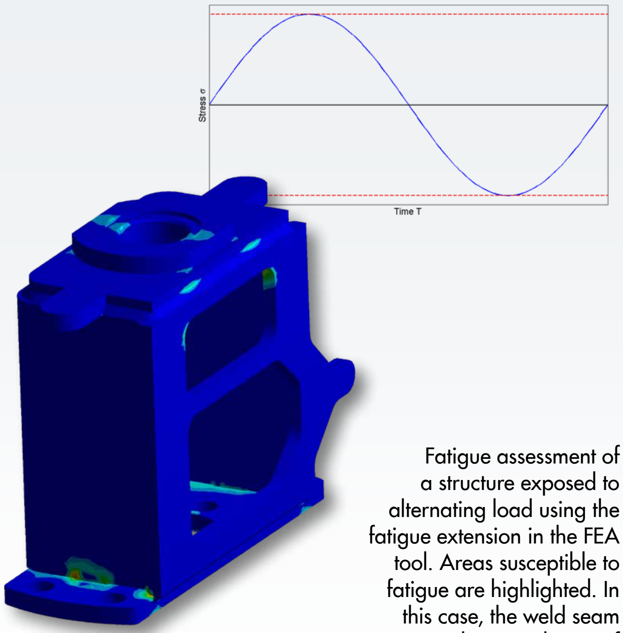
SIMULATION SERVICES



STRUCTURAL

To provide highly accurate and reliable results, a wide variety of features is applied when performing static structural analyses.
The optimization of CAD models, materials modeling, linear and nonlinear contact modeling, meshing of complex geometrical structures and scripting for customization purposes are only a few of the tasks that can be completed while performing static structural analyses.
Typical applications of this specific type of analysis cover static linear and nonlinear stress-strain analyses as well as the dynamic assessment of structures. The latter covers various analyses, such as FKM analysis using an FKM extension in the FEA tool.
In case the simulation focuses on the structural behavior of a specific area, using the submodeling approach increases the accuracy of the results while maintaining a reasonable calculation time.

Representative structural analysis focusing on weld seam stress



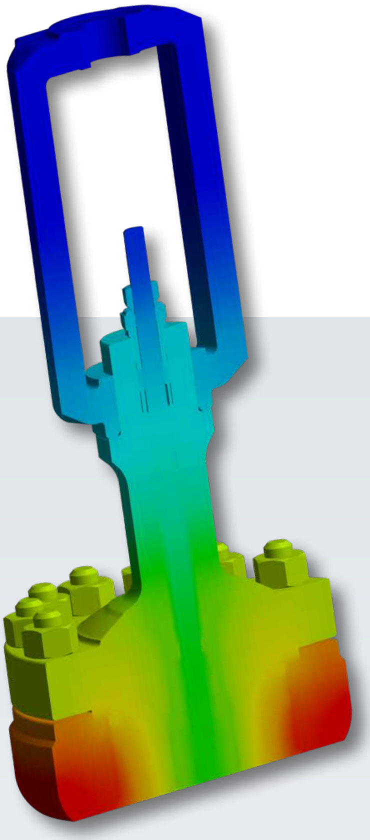
FATIGUE ASSESSMENT

Fatigue assessments are used to analyze structures that are exposed to cyclic loads considering individual material properties. To evaluate a structure regarding its lifetime, two approaches are generally used:
Based on a static structural analysis, a fatigue extension in the FEA tool evaluates results, such as life, damage or the safety factor, against fatigue of a component. This first approach takes into account different mean stress theories and the materials S/N curve as well as pulsating or alternating loads.
S/N curves are mainly available for standard materials, which makes the second approach very attractive. This second approach follows the FKM guideline and covers a wide variety of materials. It additionally enables the analysis of the entire structure as well as local areas, such as weld seams. Results are based on analytical formulas that serve to determine the structure's lifetime.

Fatigue assessment of a structure exposed to alternating load using the fatigue extension in the FEA tool. Areas susceptible to fatigue are highlighted. In this case, the weld seam represents the critical area of this structure.

THERMAL

To ensure the proper functioning of our components under thermal influence, simulations of thermal behavior (steady state/transient) considering convection, radiation and thermal interaction between components are carried out.
We are able to investigate the heat transfer for various applications, including valves for cryogenic and high-temperature service, while considering environmental boundary conditions, such as insulation, cold boxes or higher ambient temperatures.
Our library contains standard engineering materials, including metals, polymers and various fluids.

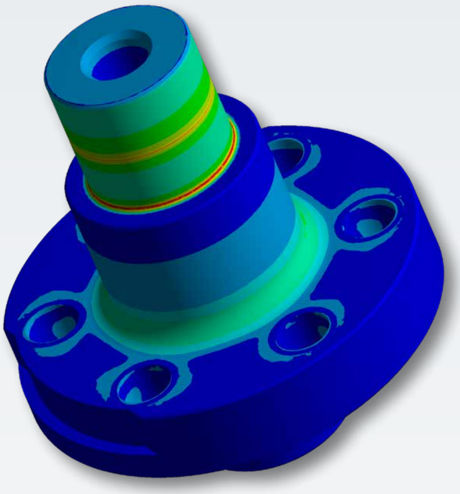


Temperature profile

DESIGN BY ANALYSIS (DBA)

Usually, we verify pressure equipment using Design by Formulae (DBF) according to the EN 12516-2, ASME B16.34 and ASME BPVC standards. In case of special designs where the standards do not provide formulas, we can verify these parts using Design by Analysis (DBA) according to EN 13445-3 Annex B.
DBA includes the following:

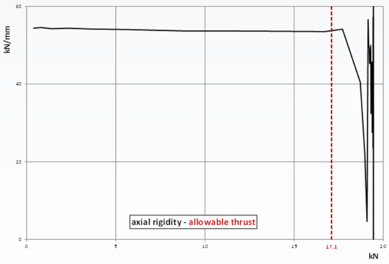
- Elastic analysis
- Plastic analysis
- Creep
- Fatigue

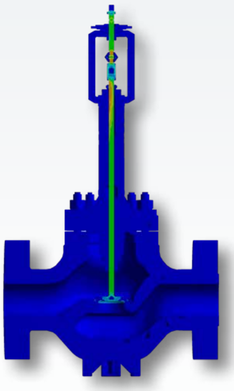


Stress profile

BUCKLING

Valve stems are exposed to high axial forces. Especially long stems in valves with insulating sections are vulnerable to buckling. In addition to calculations based on the formulas provided by Euler etc., we use FEA to determine the maximum allowable actuator force before the onset of buckling for individual valve designs.





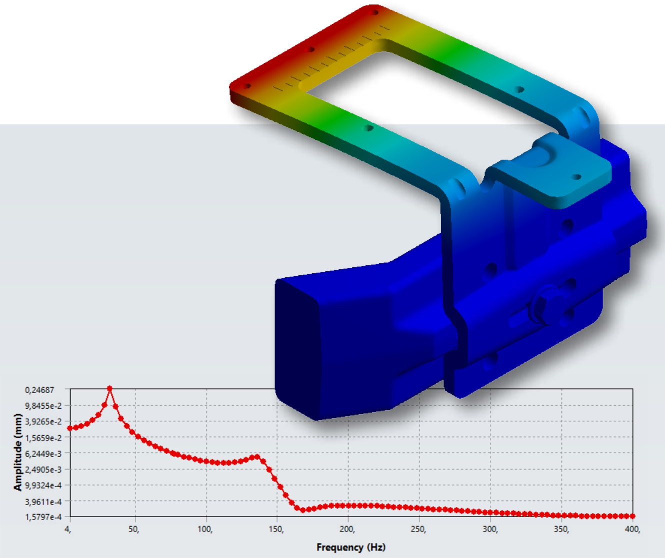
Equivalent stress in a valve with insulating section.

SIMULATION SERVICES

SEISMIC

For machines or equipment installed in earthquake hot zones, seismic evaluation according to the ASCE/SEI 7 or DIN EN 1998/EC8 standards for example, provides a numerical assessment of their seismic response. The response spectrum analysis method is applied to calculate the stress-displacement response of the equipment under seismic load (seismic spectrum) and check its compliance with a given standard. This analysis also has the following features:

– Superposition of seismic loads in different directions
– Mode analysis

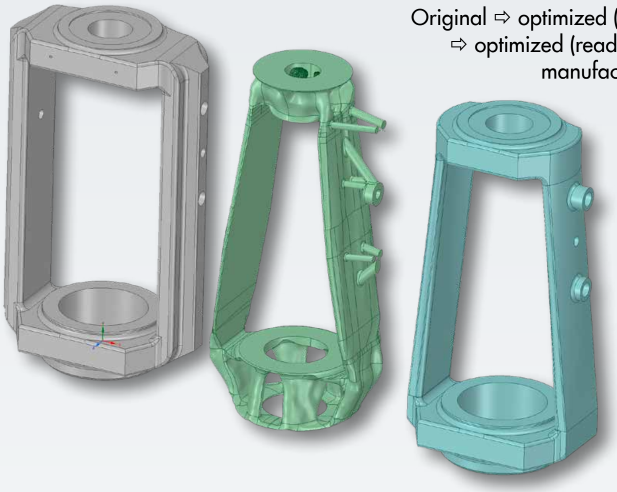


Structural displacement due to seismic loads with different excitation frequencies

TOPOLOGY

Topology optimization gives us an opportunity to achieve a similar outcome (e.g. strength) but with minimum material usage and low cost of production for a part. The optimization objectives can be:

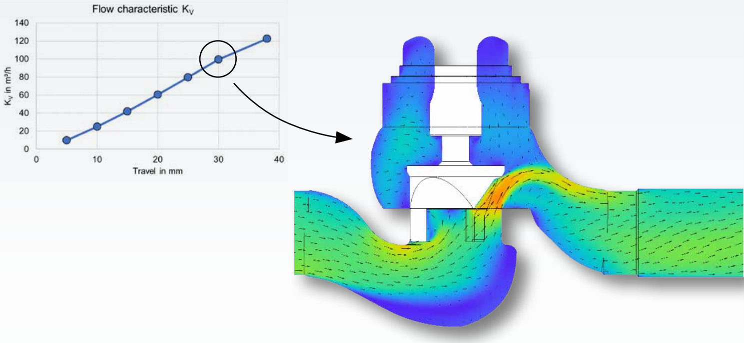
– Minimize part weight
– Minimize part volume
– Minimize global/local stress on the part
– Minimize part displacement
– Minimize reaction force of the part



Original ⇨ optimized (raw) ⇨ optimized (ready for manufacture)

STATIONARY FLOW

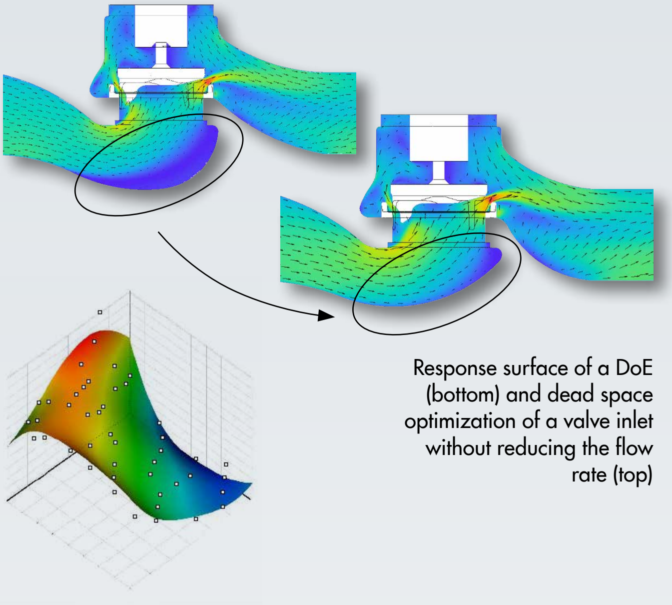
Numerical solving of the fundamental flow equations enables us to gain an insight into the pressure, velocity and temperature distributions inside a valve. In addition to pressure loss and flow characteristics, flow-induced forces and torques can be evaluated. The pressure distribution can be used as input data for further structural calculations, fatigue analysis or fluid-structure interaction (FSI). With certain boundary conditions, the evaluation of valve-specific values (e.g. K_V, x_{Fz} and x_T) is also possible. They are essential to valve sizing. Dead space analyses can be performed if special requirements have to be met. In general, simulations can be performed either turbulent or laminar flow regimes.



Simulated valve characteristic (left) and corresponding CFD result (right)

FLOW OPTIMIZATION

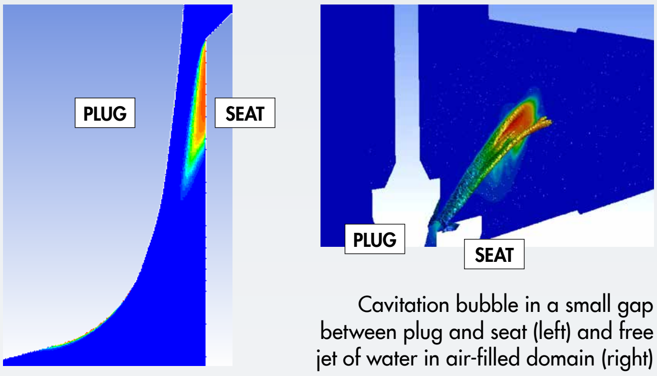
The results of a flow simulation can be used to improve the geometry to achieve certain optimization goals. They can be, for example maximize the flow rate, minimize dead spaces or eliminate potential sources of noise. Lower noise emissions can be achieved by improving the x_{Fz} value by delaying the onset of cavitation.
Unwanted flow conditions (e.g. large vortices) can induce additional vibration, noise sources and reduce the flow rate due to additional pressure losses. These flow conditions can be eliminated by a targeted manipulation of the valve geometry.
A parameter study can be used, e.g. to optimize certain parts of the assembly. Through calculation of targeted parameter combinations in a design of experiments (DoE), a qualitative statement can be made for all possible combinations in the chosen parameter space.



Response surface of a DoE (bottom) and dead space optimization of a valve inlet without reducing the flow rate (top)

MULTI-PHASE FLOW

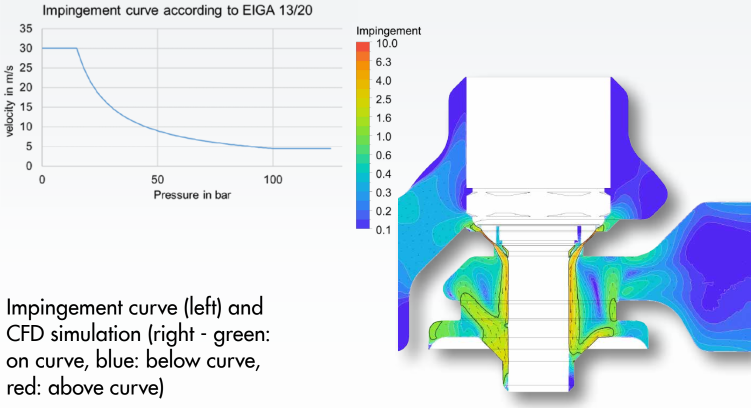
When the pressure falls below the vapor pressure at the vena contracta, vapor bubbles start to form, which can cause serious damage to the valve body or piping when they implode in regions of higher pressure. Targeted multi-phase simulations enable us to track the origin and path to the implosion region. Early on in the development process, potential weak spots can be identified and eliminated. An evaluation of the liquid pressure recovery factor F_L of valves is also possible.



Cavitation bubble in a small gap between plug and seat (left) and free jet of water in air-filled domain (right)

IMPINGEMENT ANALYSIS ACCORDING TO EIGA 13/20

Oxygen applications, in particular with oxygen gas, have to be evaluated critically due to the risk of ignition. With impingement analyses, surfaces along the flow path are rated based on pressure and temperature values according to EIGA 13/20. Based on this worst-case assessment, some materials can be ruled out or cleared. In addition, non-impingement sites (surfaces with low ignition probability due to particle impact) can be identified so that additional materials can be applied safely.

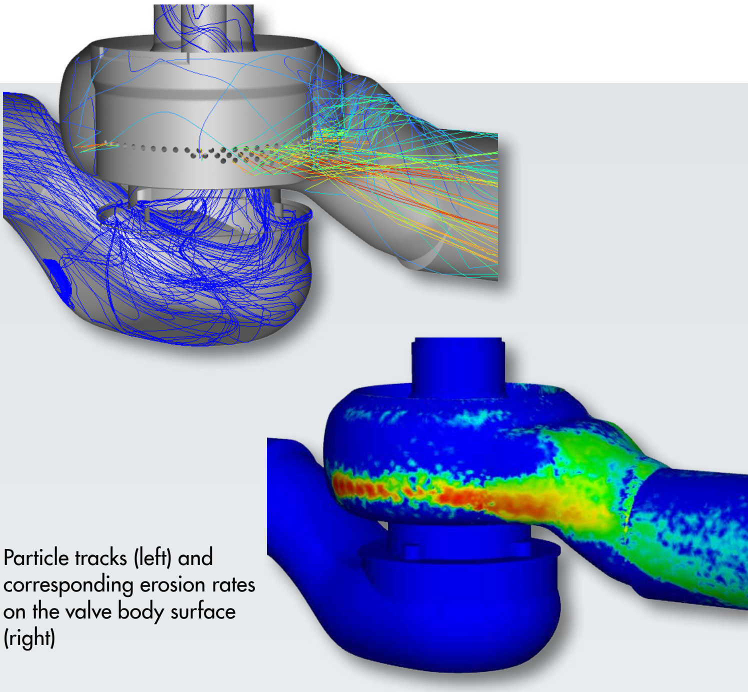


Impingement curve (left) and CFD simulation (right - green: on curve, blue: below curve, red: above curve)

SIMULATION SERVICES

PARTICLE

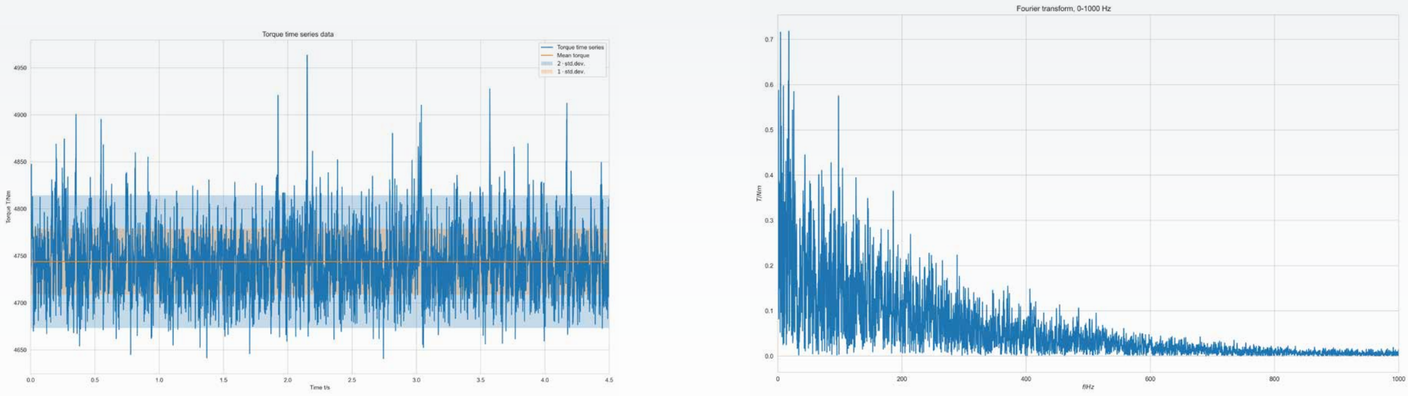
Based on flow simulation results, particle simulations can predict the trajectories of particles with different shapes, sizes and masses. The computational effort is notably lower compared to the initial flow simulation. Typical particles can be welding residue, metal chips or other fluid contaminants. Through particle simulations, we can gain insights into impact angle, velocity and frequency. With this information, an assessment of vulnerable parts (e.g. bellows) can be made and general safety limits for particle impact can be checked.



Particle tracks (left) and corresponding erosion rates on the valve body surface (right)

TRANSIENT FLOW

Time-dependent simulations provide additional information on the flow, especially turbulence. Along with fluctuations in pressure and velocity, time-dependent boundary conditions (e.g. pressure loss at the inlet) can be implemented. Virtual probes enable us to gather time-dependent process data at different positions. These positions may be impossible to probe on the physical test specimen. These data can be used, for example as the basis for a digital twin or to build a reduced order model (ROM).
Frequency-dependent analyses can determine characteristic frequencies from longer time spans of periodic flow separation, for example. Time-dependent forces or torques can be used as boundary conditions for fatigue analysis.



Transient results plotted in time domain (left) and frequency domain (right)

IMPROVING INJECTION MOLDING PROCESS AND QUALITY

Injection molding simulations support the new development and re-engineering of injection-molded plastic parts to optimize product design and manufacturability. Therefore, they help cut cost for development testing and shorten the time-to-market. The outcome strongly depends on the chosen type of plastics. A database with a wide range of plastic materials, including fiber-reinforced types, is available and secures a high reality grade in results. How much the process can be improved mainly depends on the filling behavior and ability, cooling state and warpage.

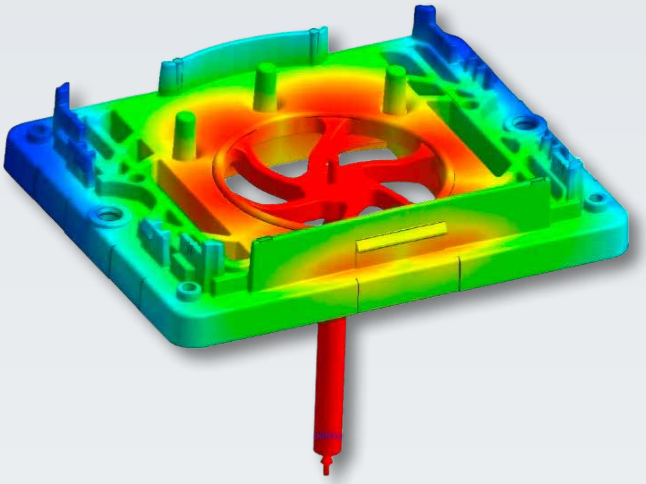
a) Filling problems and low-pressure regions are detectible at an early stage of designing. Injection molding simulations provide individual reality-inspired melt delivery and cooling systems, including sprues, runners, gates, coolant channels and mold base. Real machine data from different injection molding machine models ensure a realistic process simulation.

b) Cooling mode enables us to make exact predictions of the cooling behavior of injection-molded parts to save energy and reduce the cycle time to establish a high level of production efficiency. The cost-intensive cycle time for production depends to a great extent on the time required for the cool-down until demolding of the single injection-molded part. Otherwise, too fast or unequal cooling may cause quality problems. Such problems are solvable by making design changes to the in-mold cooling channels and ensuring a suitable temperature control of cooling media. 3D numerical simulations tackle complex injection-molded parts with high reliability and deliver their results in colored figures and animations. Engineers are enabled to detect potential heat spots from comprehensive analyses and iterate on design changes to optimize the later process time at the early stages.

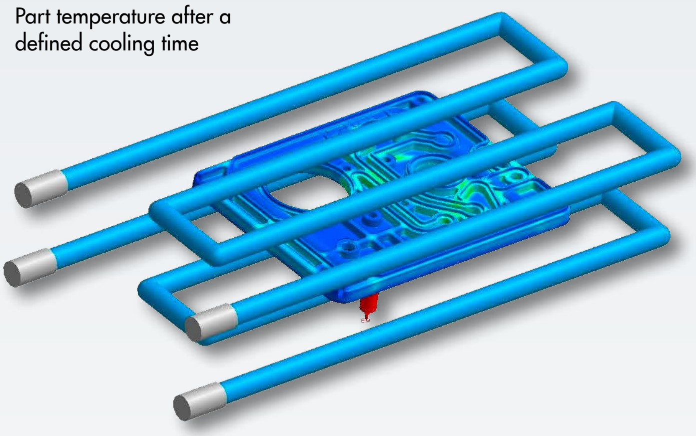
c) The warp analysis allows users to validate the part-deforming ratio of shrinkage effects and to identify warpage causes at an early stage. For fiber-reinforced materials, the warp module incorporates fiber composite theories and fiber orientation results to predict how anisotropic shrinkage, residual stress effects and material viscoelasticity will affect warpage and flatness of the ready-produced part. The results are existential for an exact fitting and tightness forecast in further applications.

Did a task immediately come to your mind or would you like more information? Please feel free to contact us.
Our simulation experts look forward to discussing any issues with you to develop customized solutions that meet your specific needs.

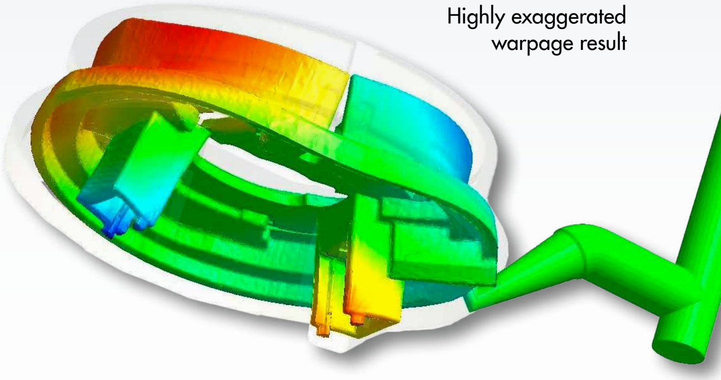
Filling time of an injection-molded part



Part temperature after a defined cooling time



Highly exaggerated warpage result



SAMSON AT A GLANCE

STAFF

- Worldwide 4,500
- Europe 3,700
- Asia 600
- Americas 200
- Frankfurt am Main, Germany 2,000

INDUSTRIES AND APPLICATIONS

- Chemicals and petrochemicals
- Food and beverages
- Pharmaceuticals and biotechnology
- Oil and gas
- Liquefied Natural Gas (LNG)
- Marine equipment
- Power and energy
- Industrial gases
- Cryogenic applications
- District energy and building automation
- Metallurgy and mining
- Pulp and paper
- Water technology
- Other industries

PRODUCTS

- Valves
- Self-operated regulators
- Actuators
- Positioners and valve accessories
- Signal converters
- Controllers and automation systems
- Sensors and thermostats
- Digital solutions

SALES SITES

- More than 50 subsidiaries in over 40 countries
- More than 200 representatives

PRODUCTION SITES

- SAMSON Germany, Frankfurt, established in 1916
  Total plot and production area: 150,000 m²
- SAMSON France, Lyon, established in 1962
  Total plot and production area: 23,400 m²
- SAMSON Turkey, Istanbul established in 1984
  Total plot and production area: 11,100 m²
- SAMSON USA, Baytown, TX, established in 1992
  Total plot and production area: 20,000 m²
- SAMSON China, Beijing, established in 1998
  Total plot and production area: 47,000 m²
- SAMSON India, Pune district, established in 1999
  Total plot and production area: 28,000 m²
- SAMSON Russia, Rostov-on-Don, established in 2015
  Total plot and production area: 24,000 m²
- SAMSON AIR TORQUE, Bergamo, Italy
  Total plot and production area: 27,000 m²
- SAMSON CERA SYSTEM, Hermsdorf, Germany
  Total plot and production area: 14,700 m²
- SAMSON KT-ELEKTRONIK, Berlin, Germany
  Total plot and production area: 1,100 m²
- SAMSON LEUSCH, Neuss, Germany
  Total plot and production area: 18,400 m²
- SAMSON PFEIFFER, Kempen, Germany
  Total plot and production area: 20,300 m²
- SAMSON RINGO, Zaragoza, Spain
  Total plot and production area: 19,000 m²
- SAMSON SED, Bad Rappenau, Germany
  Total plot and production area: 10,400 m²
- SAMSON STARLINE, Bergamo, Italy
  Total plot and production area: 27,000 m²
- SAMSON VDH PRODUCTS, the Netherlands
  Total plot and production area: 12,000 m²
- SAMSON VETEC, Speyer, Germany
  Total plot and production area: 27,100 m²

SAMSON AKTIENGESELLSCHAFT

Weismuellerstrasse 3 · 60314 Frankfurt am Main, Germany
Phone: +49 69 4009-0 · Fax: +49 69 4009-1507
E-mail: samson@samsongroup.com
Internet: www.samsongroup.com

SMART IN FLOW CONTROL