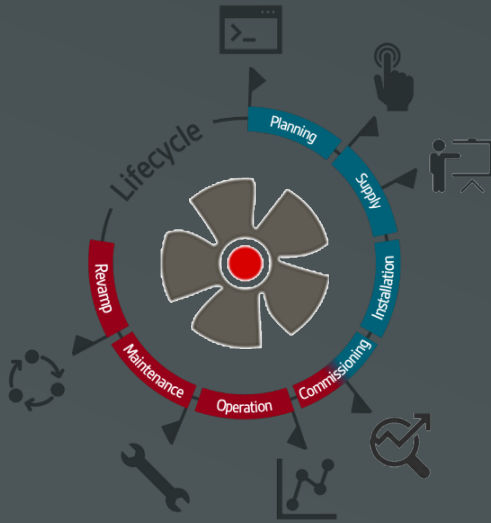


Modeling & simulation of critical processes



The Digital Twin combines machine data and process parameters to create a realistic digital replica – for simulation, virtual commissioning and real time monitoring. The Digital Twin not only provides data, but insights. For well-founded decisions, reliable processes & a deeper understanding across plants.

More transparency via a holistic perspective.

Informed decisions through data- driven analysis.

Reduced diagnosis and downtimes when faults occur.



Simulation-based Engineering incl. API 617

[Learn more](#)



Virtual Commissioning

[Learn more](#)



Operator Training

[Learn more](#)



Virtual Troubleshooting

[Learn more](#)



Smart Monitoring

[Learn more](#)



Smart Maintenance

[Learn more](#)



Smart Modernization

[Learn more](#)

Digital Twin

What makes us different



Holistic

Includes all relevant process components, consumer & control systems



Fully dynamical

Process changes like startup, shutdown, consumer changes etc.



Wide range

Works beyond normal operation to capture effects like surge or reverse rotation



Optimization tools

Model is trained with process data to create high fidelity Digital Twins



Realtime & open-end simulation



One model – multiple lifecycle applications

From planning to maintenance & revamp



Connectable

Hardware-in-the-loop, Model-in-the-loop & Software-in-the-loop setups



Independent since 20 years

100% owned by us, 100% control for customer solutions



Simulation helps in selecting the control strategy and actuators. This ensures best dynamics and optimal control performance for the machine and for the overall process.

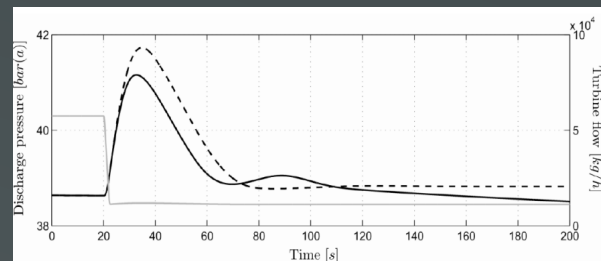
ASV design selection for booster gas compressors

Setup & Scenario

- ▶ 1-staged Booster compressor in power-plant with IGV @ constant speed & anti-surge valve
- ▶ Turbine flow from 100 % to 20 % in 2 sec with simulation of different valve sizes

Result

- ▶ Increased valve size decreases discharge side pressure overshoot & gradient
- ▶ Prevented discharge pressure value & gradient from exceeding limits during turbine load rejection
- ▶ Compressors was able to reach unload operation to stand by for prompt turbine restart



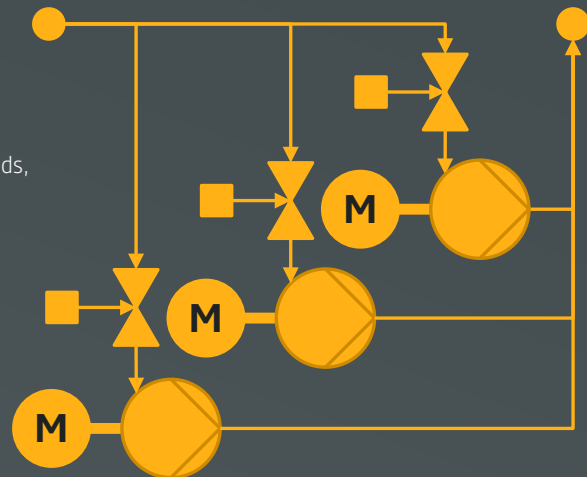
Optimization of a water pump station

Setup & Scenario

- ▶ Model of 3 parallel feed pumps incl. hydraulic characteristics, control behavior for variable speed, pressure and flow behavior under variable loads,
- ▶ Simulation set up to test different pump sizes and combinations

Result

- ▶ Optimization criteria: low energy consumption (i.e., high efficiency) for a given load range and, at the same time, as few switching operations as possible (higher pressure stability and lower wear)
- ▶ Found optimal pump size and vendor for as the best trade-off for typical daily demand based on current requirements and estimated requirements in 10 years.



API 617 defines the highest standards for compressor design, reliability, and performance. Mastering simulation according to this standard is essential to ensure mechanical integrity and compliance. With proven expertise in **API 617 simulations**, we provide the precision and confidence needed for safe and efficient operation of critical rotating equipment.



6-staged nitrogen recovery unit compressor in LNG plant

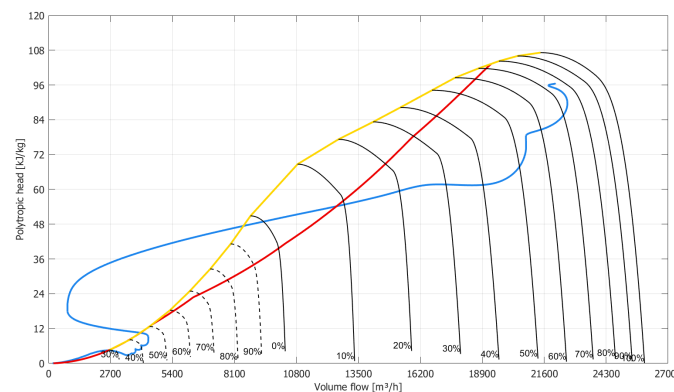
Setup & Scenario

- ▶ Control verification & ASV design under various start-up, stop, ESD & upset scenarios acc. API 617
- ▶ Driver verification under various start-up conditions acc. API 617

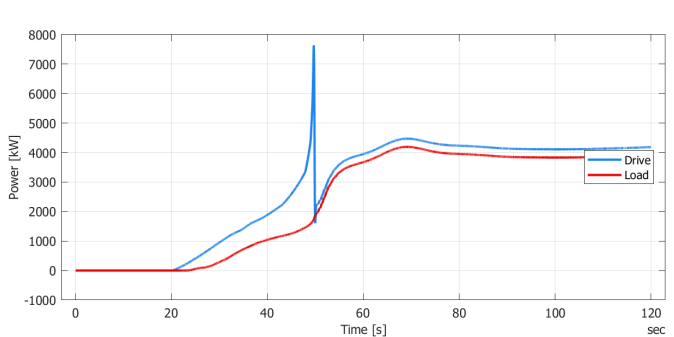
Result

- ▶ Modified anti-surge valve philosophy: 2 valves used instead of 1 valve, minimizing risk of surging during ESD events
- ▶ Cvs-values of anti-surge valves defined based on flow rates, and bypass pipe dimensions derived from flow velocities
- ▶ Pressure peaks identified during highly transient events led to adjustments of pipe design pressures & safety valve setpoints
- ▶ Suction pressure limits defined as start-up permissive criteria, ensuring the driver can accelerate the compressor to rated speed under varying load conditions

Working point of 1st stage during ESD turnaround



Motor & compressor power during startup



Digital Twin

Virtual Commissioning



Simulation is put against plant or asset control for ultra-realistic testing of closed-loop control, sequences & dangerous situations. The technical risk is greatly minimized. Saves time & cost during hot commissioning.

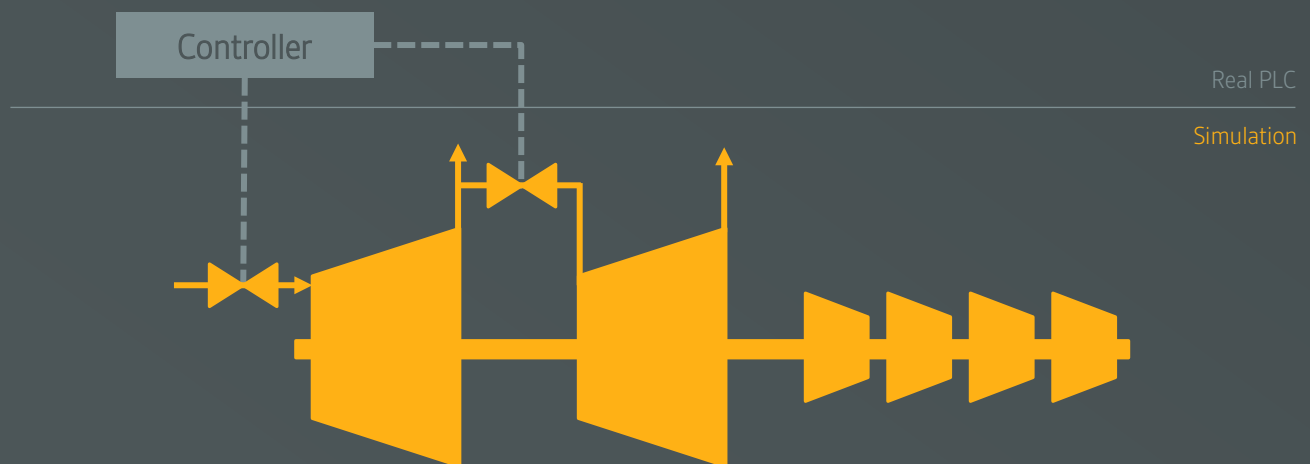
Virtual commissioning of a 2-staged extraction turbine

Setup & Scenario

- ▶ Revamp of obsolete Woodward speed and Ascania extraction controller + valve actuators
- ▶ Customer requirements: On-site activities finished within tight time constraints, stable & high-performance operation from first startup
- ▶ Simulation connected to new PLC-based controller, Test of normal operation, startup & shutdown + pre-tune turbine controls

Result

- ▶ Requirements successfully fulfilled
- ▶ Shorten plant startup to stable operation from 48 h to 8 h



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Operator Training



Simulation is used to train normal & abnormal operation as well as dangerous situations without affecting the plant. Awareness is built even before commissioning. The risk of improper operator reactions is minimized.

Operator training of cracked gas, ethylene and propylene compressors in a steam cracker plant

Setup & Scenario

- ▶ ASC upgrade of 5-staged Cracked Gas Compressor, 4-stage Ethylene Compressor, 3-staged Propylene Compressor in Ethylene cracker plant
- ▶ Dynamic real-time models connected to ABB 800xA Controller via 4-20 mA signals

Outcome

- ▶ Theoretical and practical part to explain all new features of upgraded anti-surge control
- ▶ Various scenarios tested with Operators from simple to complex (process disturbance, operator override, suction/discharge pressure limitation, fallback strategies, advanced ASC features)
- ▶ New DCS graphics presented and explained



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Virtual Troubleshooting



Simulation is used to identify the root cause of process interruption or breakdown and offers a tailored solution. The goal is to avoid unplanned downtimes and restarting delays.

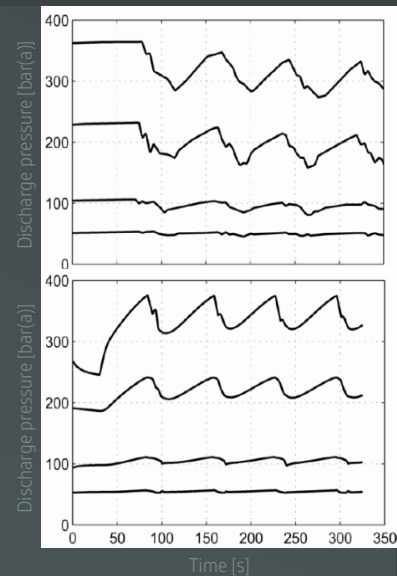
ESD of 4-staged Synthesis Gas Compressor

Incident

- ▶ 250 bar discharge pressure with 3 anti-surge valves
- ▶ 2x ESD per year caused by fast process variation

Result

- ▶ Analysis of inter-stage effects revealed coupling of all anti-surge control loops that finally caused strong oscillation (~60 bar in stage 4) via uncoordinated opening of anti-surge valves
- ▶ Optimization of control structure together with minor intervention within DCS via implementing few lines of code
- ▶ Successfully prevented further ESD



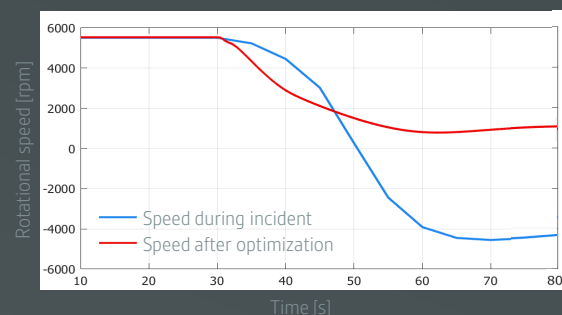
Back rotation of turbine-driven 4-staged air compressor

Incident

- ▶ Back rotation @ at 80 % of rated speed during machine ESD

Result

- ▶ First step was reproduction of incident
- ▶ Automated test of hundreds design alternatives with respect to additional blow-off valve position, size & speed
- ▶ Recommendation of additional blow-off valves & silencers
- ▶ Successfully prevented further machine back rotation during ESD
- ▶ Successfully prevented compressor surge during machine shutdown





The Digital Twin is used for continuous benchmarking. Comparison of simulated data with the current operation shows how well the asst / plant is working. Track performance as well as efficiency and identify deviations.

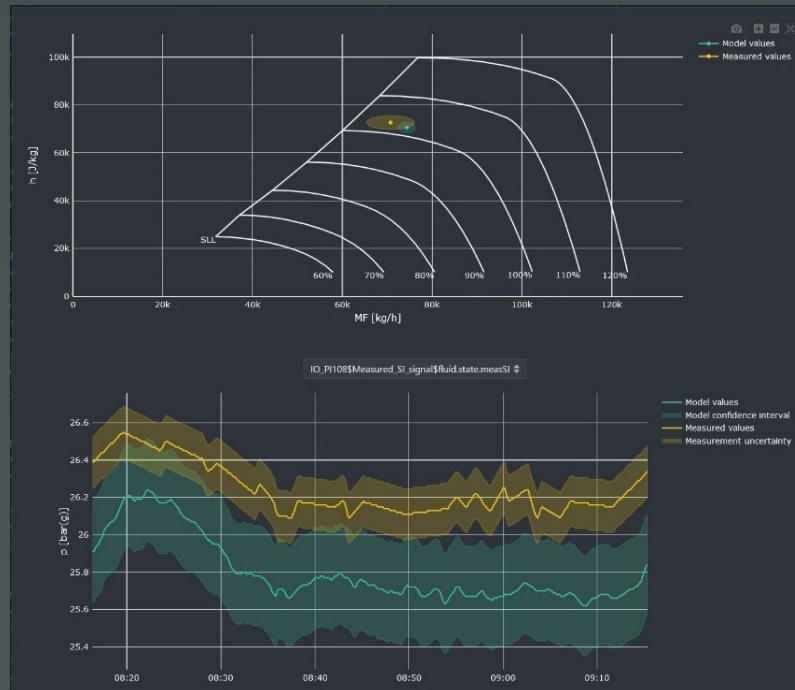
Continuous performance & failure analysis of cracked gas compressors

Setup

- ▶ Digital Twin implemented into customers OT via virtual machine
- ▶ Data interface between Digital Twin & plant archive
- ▶ METIS platform for analyzing data

Outcome

- ▶ Digital Twin trained to reference operation
- ▶ Continuous analysis of each compressor stage (upper picture) via comparison of simulation vs. measured working points
- ▶ Continuous performance analysis of heat exchanger via comparison of the outlet temperature
- ▶ Identification of drifting measurements

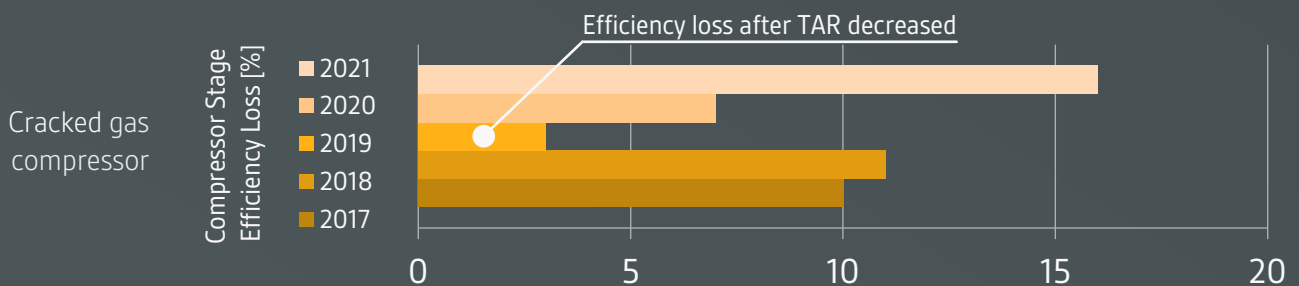




Simulation is used detects abnormal plant behavior and assists root cause analysis. The plant health can even be extrapolated to predict future degradation. Plan your maintenance measures more precisely.

Energy savings optimization for various assets

	Power savings avg. over year	Energy savings annual	Cost savings est. annual @ energy	GHG savings est. annual CO ₂ eq
Process air compressor	17 %	4,9 GWh	420k USD	1.830 t
Vapor recovery compressor	10 %	4,6 GWh	210k USD	1.710 t
Ammonia compressor	8 %	4,4 GWh	370k USD	1.620 t





Simulation is used to discover potential for improvement and increases the efficiency of machine operation and the process itself. Powerful optimization algorithms consider technical, financial and environmental factors.

Game changer for acrylic plant compressor

Setup

- ▶ Revamp project of steam-driven 3-staged compressor
- ▶ Replace CCC controller by Tricon PLC-based controller
- ▶ Completely revamped compressor and turbine controls

Result

- ▶ Digital Twin Simulation connected to Tricon PLC
- ▶ Test normal operation, startup & shutdown, test of various scenarios to pre-tune turbine and compressor controls
- ▶ Speed reduced by 900 rpm + Steam demand reduced by 5-6 t/h (~18 % saving)
- ▶ Flexible plant independent start-up due to lower steam demand



Coupled ASU & steel plant compressors

Incident

- ▶ 5 parallel compressors of different vendors
- ▶ 50 MW in total, with cross flow valve
- ▶ 2 plant sections (steel plant + ASU)

Result

- ▶ Simulation of both plant section incl. new control (18 controller with > 270 parameters)
- ▶ Proof of concept + energy savings estimation
- ▶ Development of optimized control structure, designed for high performance normal operation & save compressor shutdown, energy savings ~10 MW

