17 NOVEMBER 2022

A Fusion of Design and Simulation

A Nuclear Success Story

Dr Ben Firth, Principal Engineer, Atkins

Joined forces

- On July 3 2017, SNC-Lavalin and Atkins joined forces

SNC·LAVALIN + ATKINS

Member of the SNC-Lavalin Group

› A leading engineering and construction group in the world offering services in oil and gas, mining and metallurgy, infrastructure and power

› Major player in the ownership of infrastructure

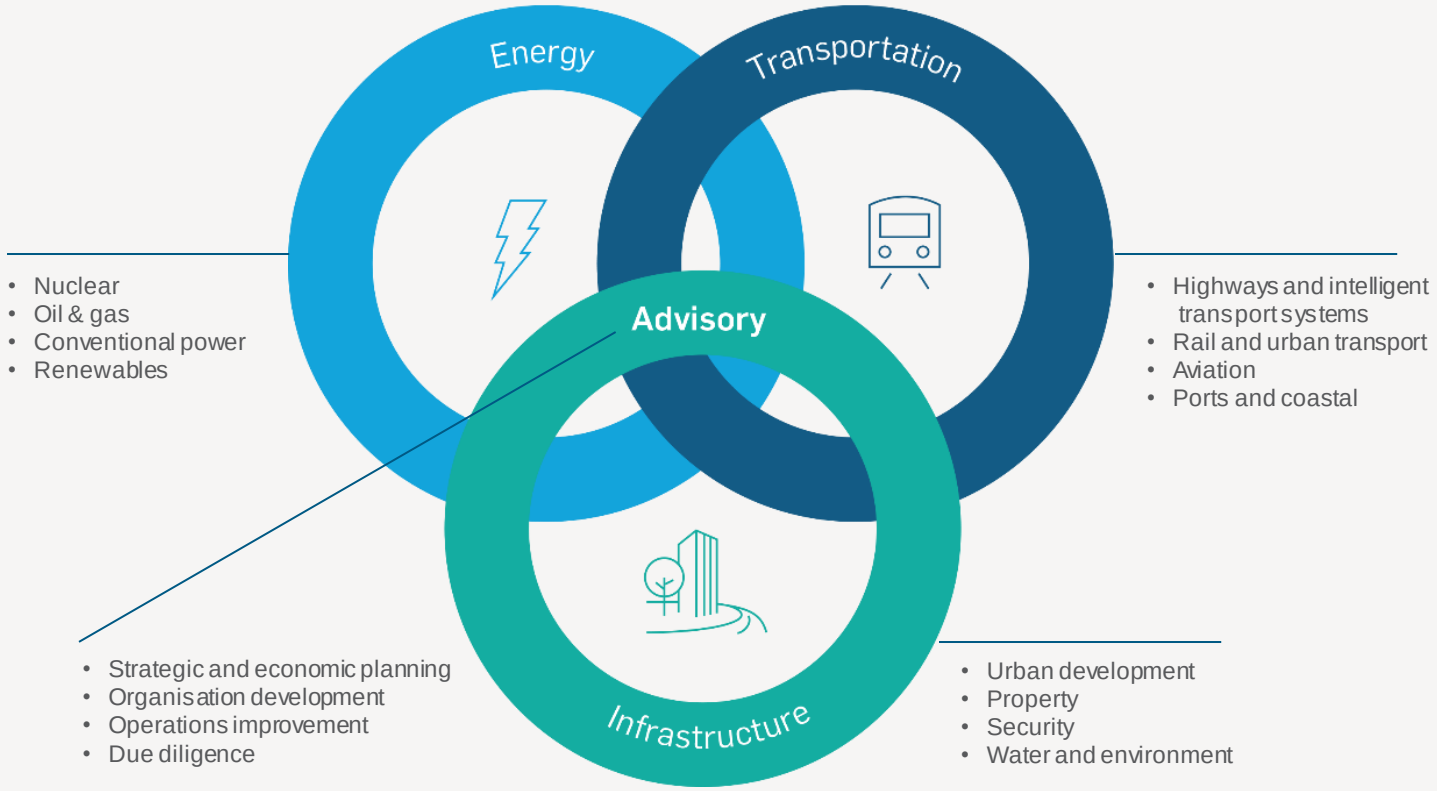
› One of the world's most respected design, engineering and project management consultancies serving infrastructure, transportation and energy sectors

AVEVA

We’re always focused on our clients

Our work spans many different sectors but our approach is always the same.

Whatever the industry, we strive to build strong relationships by understanding the challenges our clients face, sharing their vision and helping them to transform potential into reality.



Overview

Dynamic Concept Modelling

The Process

The Challenges

The Outcomes

Dynamic modelling is happening earlier in projects

Many projects are requiring dynamic modelling at concept stage, before much of the design is finalised – and not just for traditional batch plant

Incorporation of energy storage (electrical, thermal, and chemical) into processes

Renewables are not steady state, and are being combined with “Power to X”

Power demand cycles and grid loads are being factored into design

Continuous fusion has not yet been achieved

The Process

UKAEA Hydrogen-3 Advanced Technology (H3AT) Process

H3AT is intended to test fusion technologies

1/20th scale version of ITER fuel cycle:

- Tritium Processing
- Isotope Separation
- Tokamak Fuelling
- Spent Fuel Reprocessing

- By simulating the fuel cycle, H3AT seeks to develop and test technologies that will be used at full scale in a live fusion plant

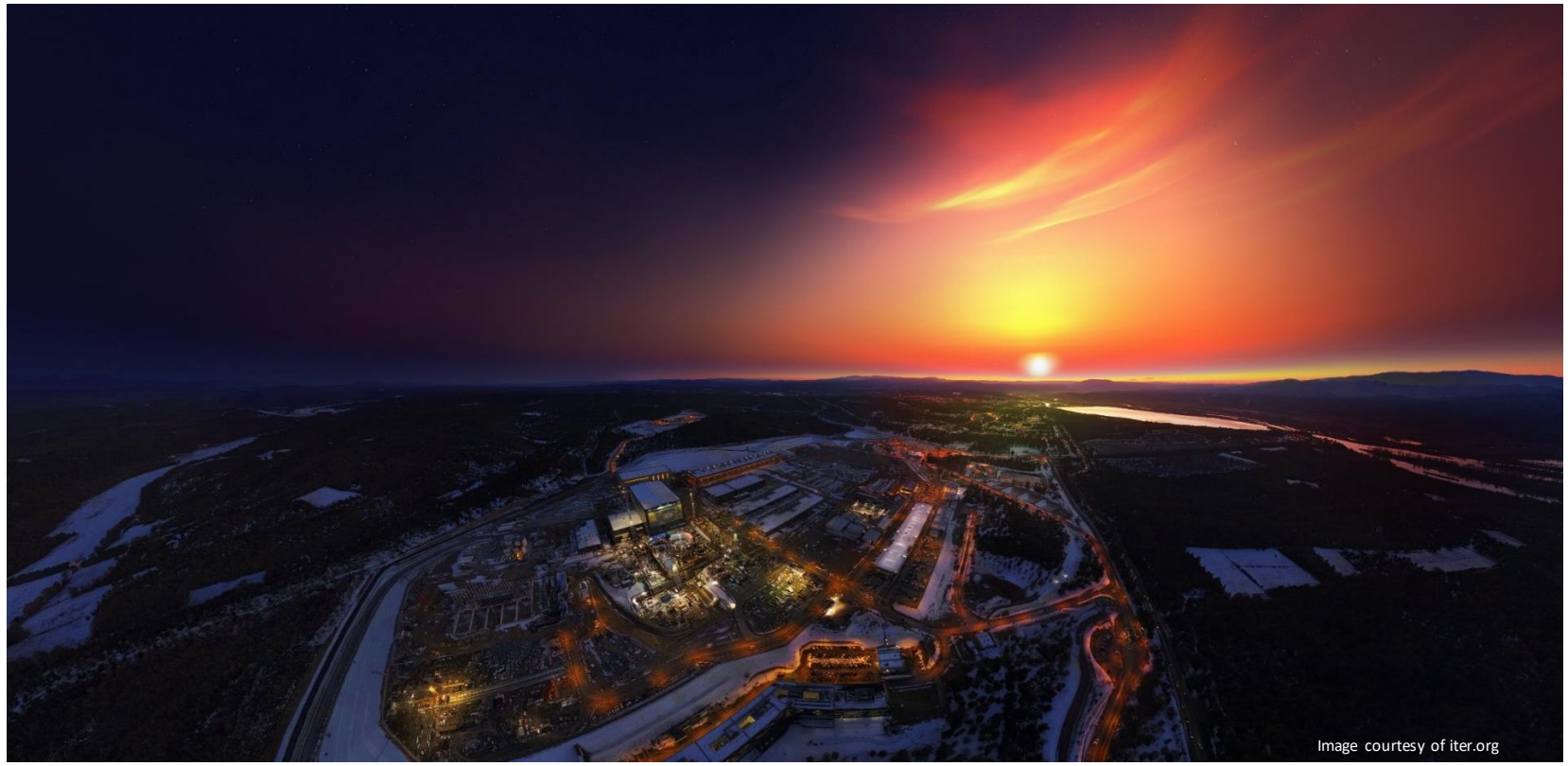
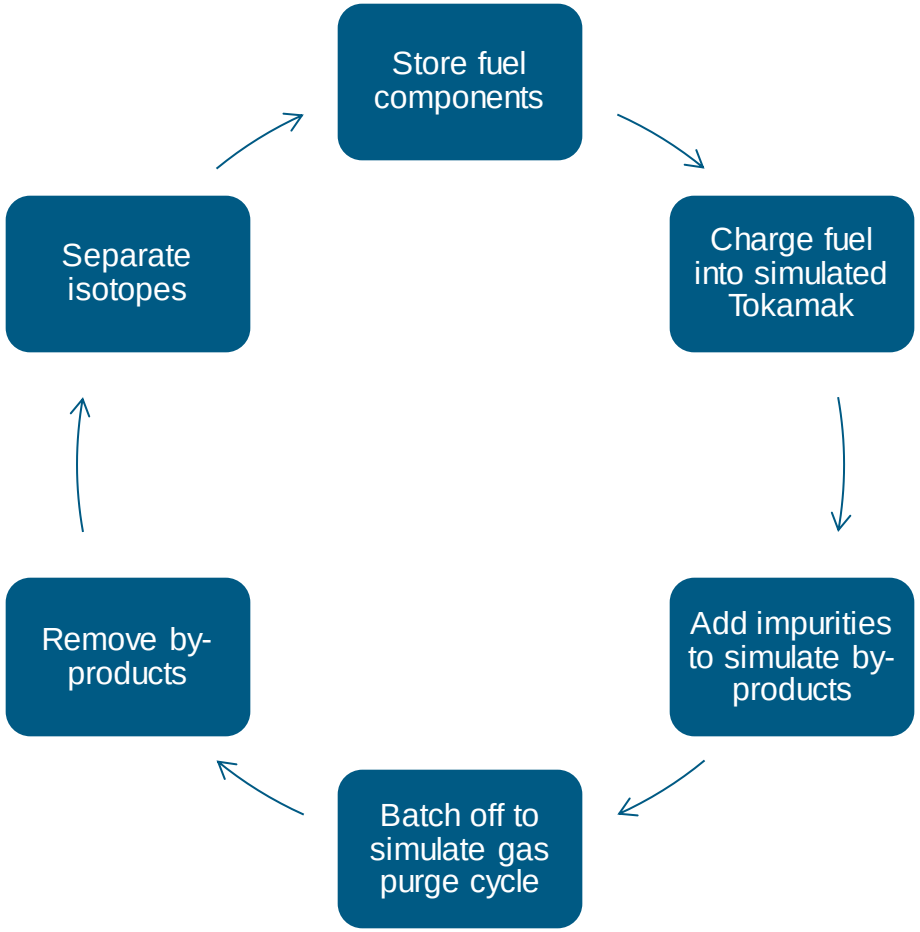


Image courtesy of iter.org

The process runs fuel around the cycle to test technologies



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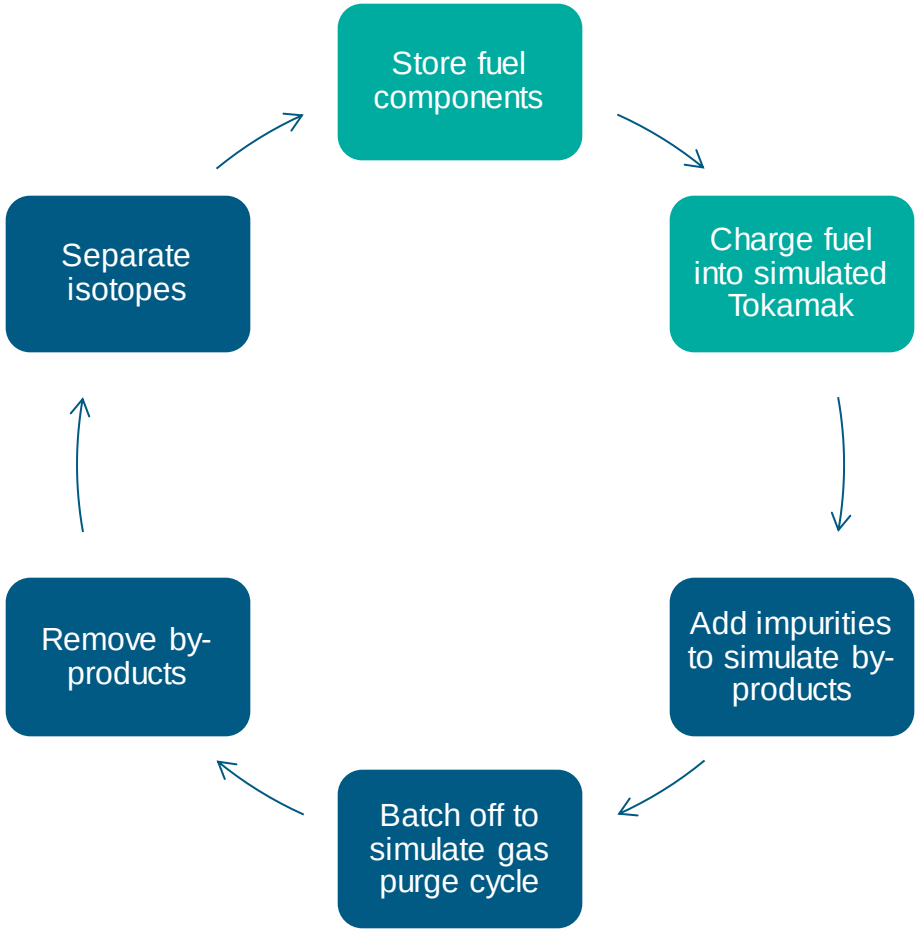
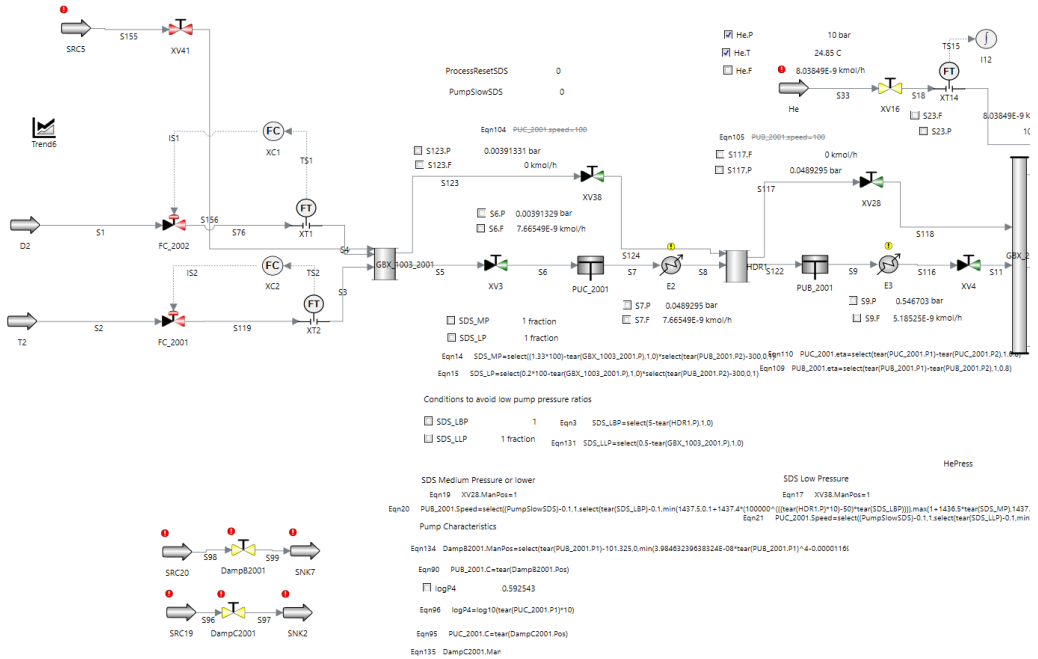
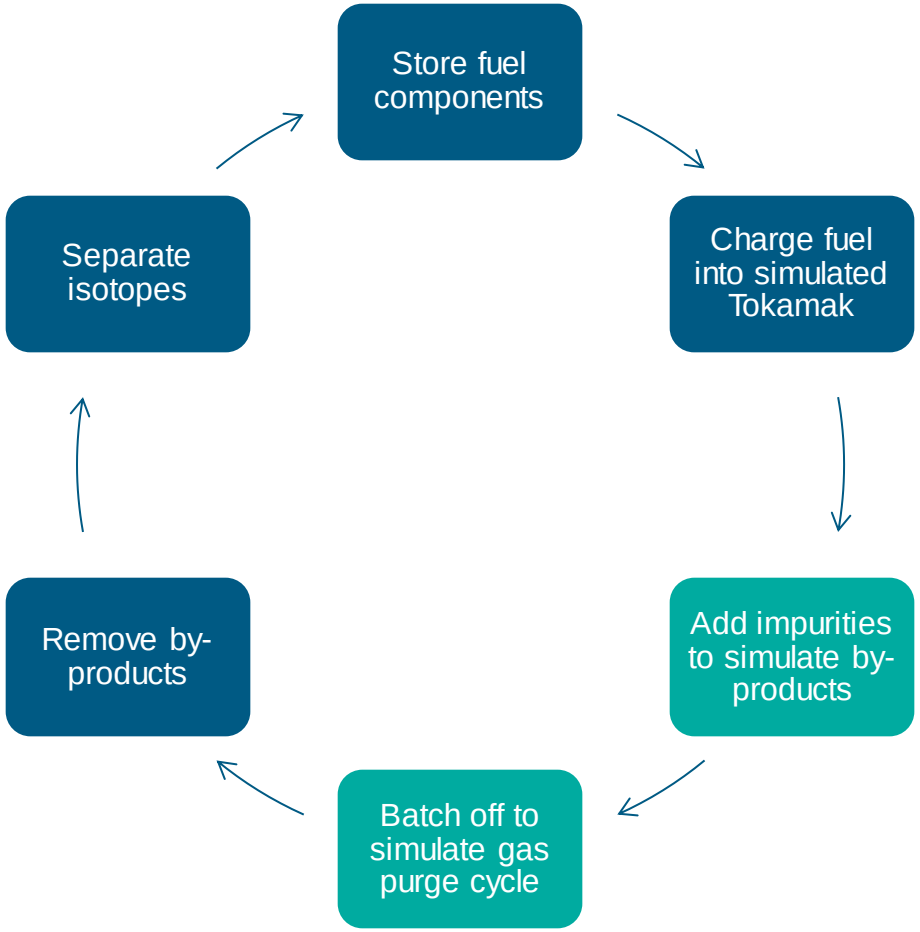
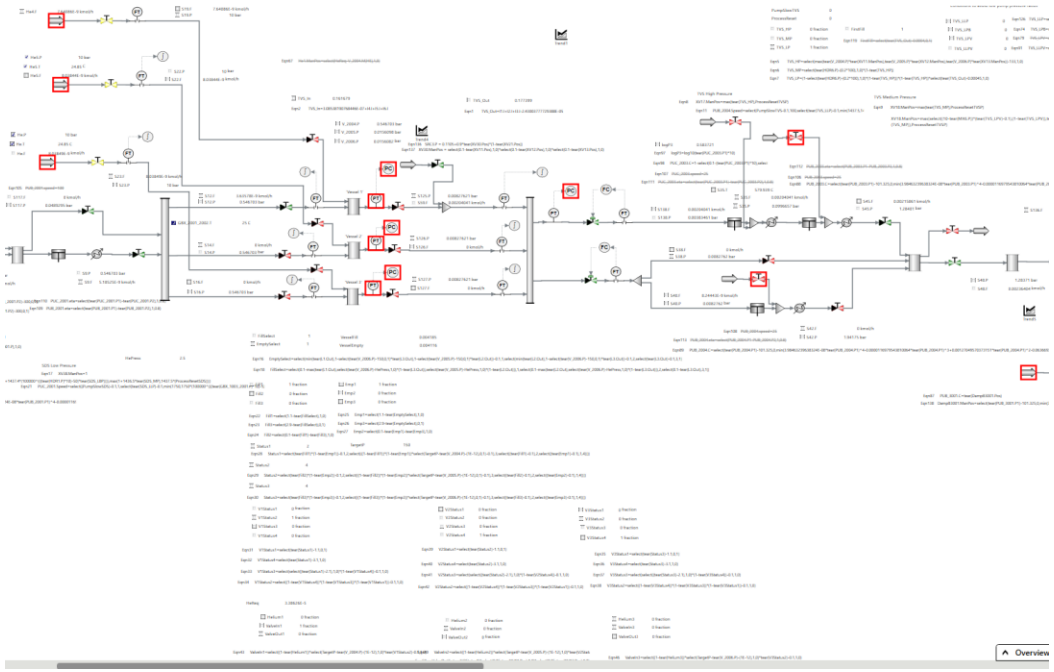




Fuel shots are added on a schedule to simulate pulsed operation of the Tokamak

The process runs fuel around the cycle to test technologies

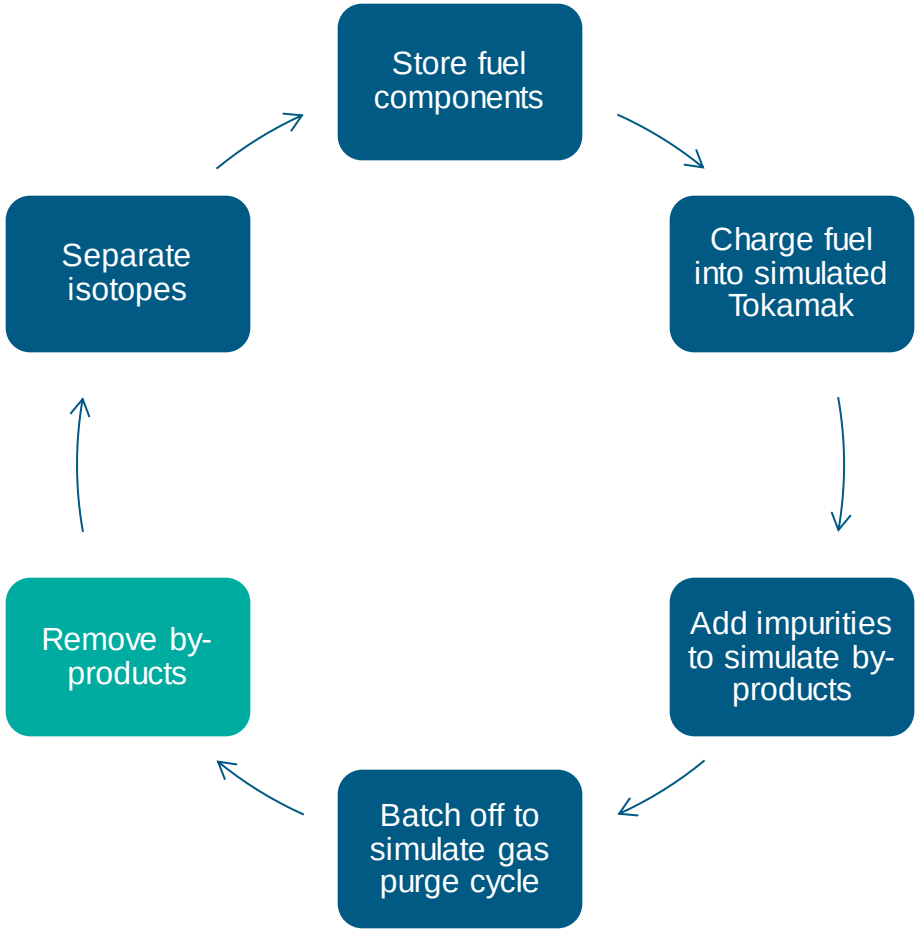


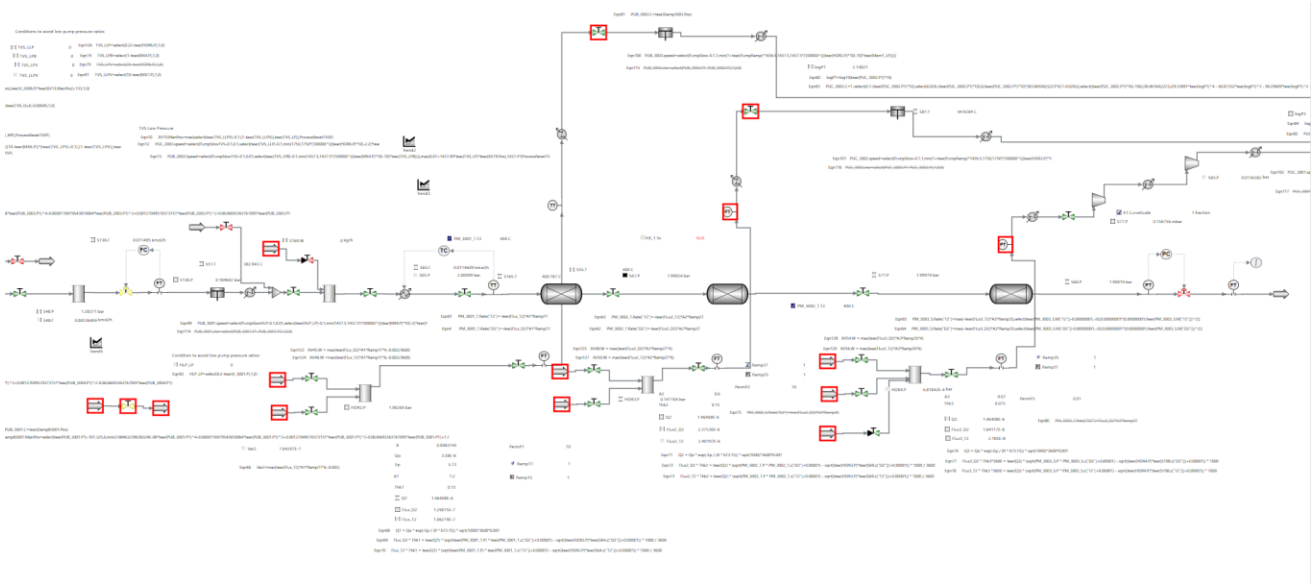


Three vessels take turns receiving and dosing impurities into fuel mixture (mimicking the cyclic operations of the gas purge pumps)

Discharge after holding time and are vacuumed down until empty

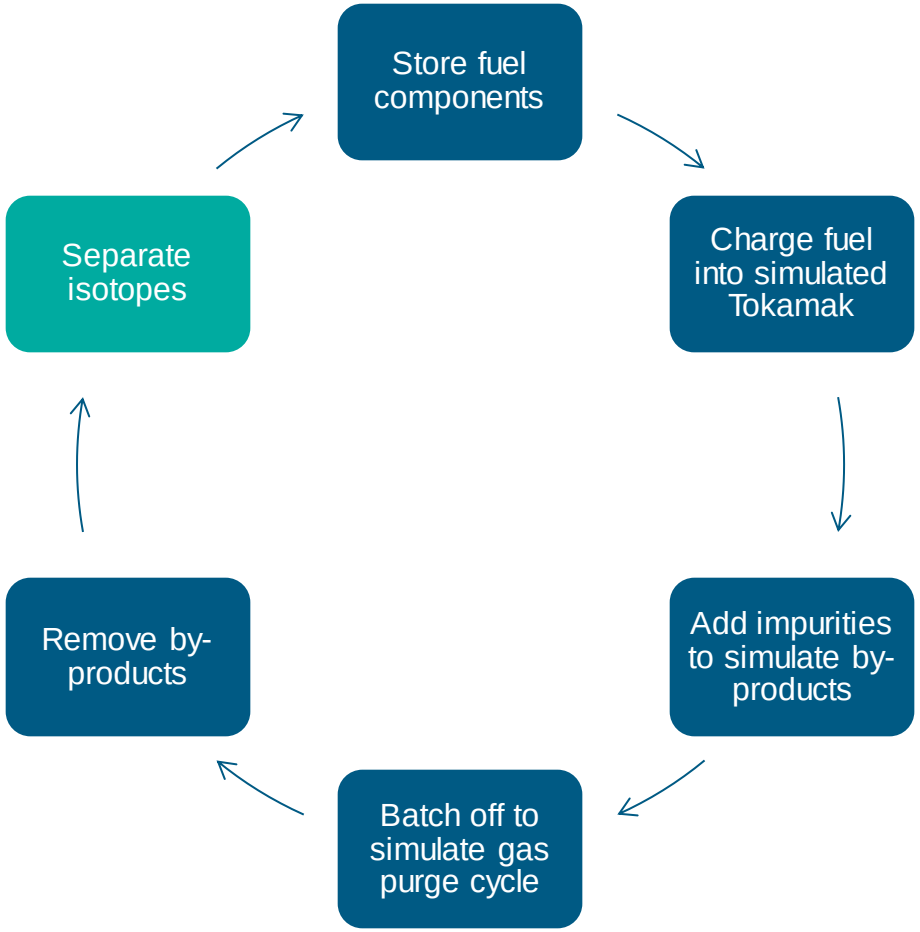
The process runs fuel around the cycle to test technologies





Palladium membranes remove hydrogen isotopes, leaving behind an impurity rich retentate for removal to impurity processing units

The process runs fuel around the cycle to test technologies



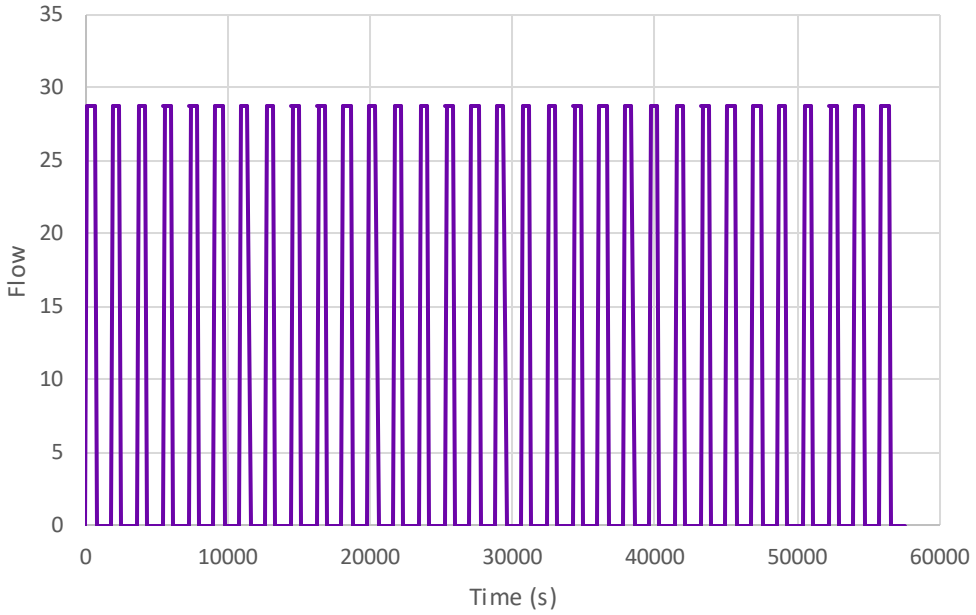
Coming Soon!

Cryogenic distillation separates out the fuel components, ready for storage, reinjection, and experimental use

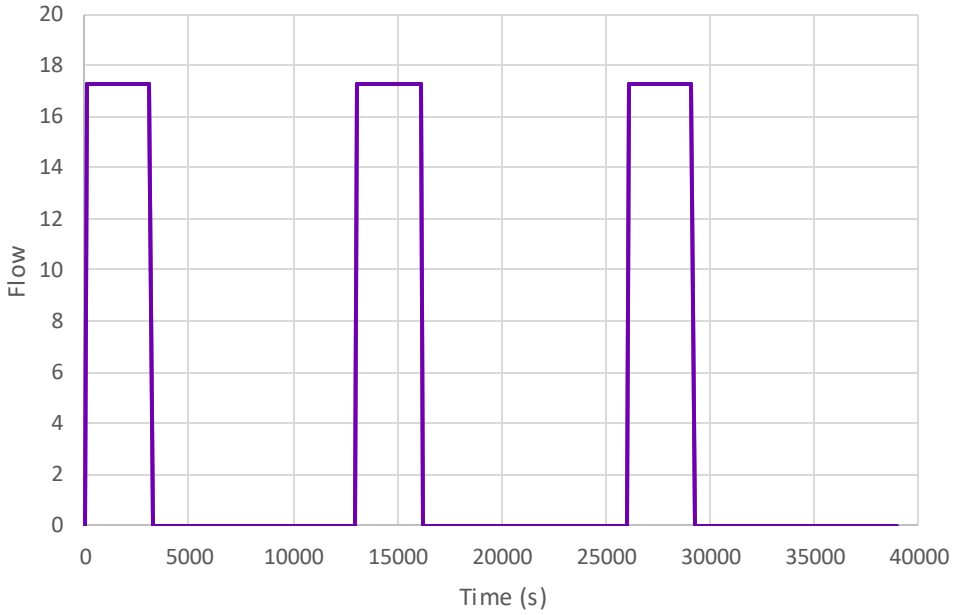
The Challenges

And how AVEVA Process Simulation helped us solve them

The process is never in steady state



Case 1: Short Pulse



Case 2: Long Pulse

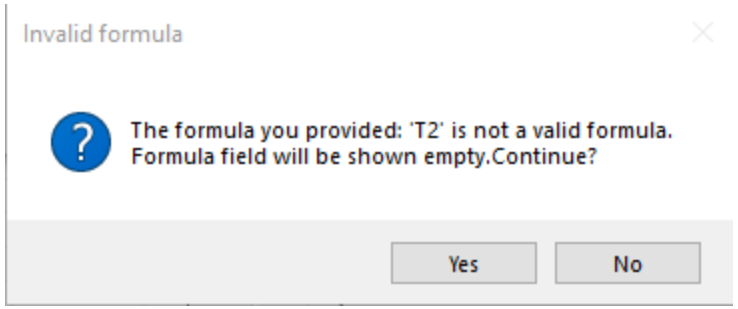
Modelling unusual processes requires unusual solutions

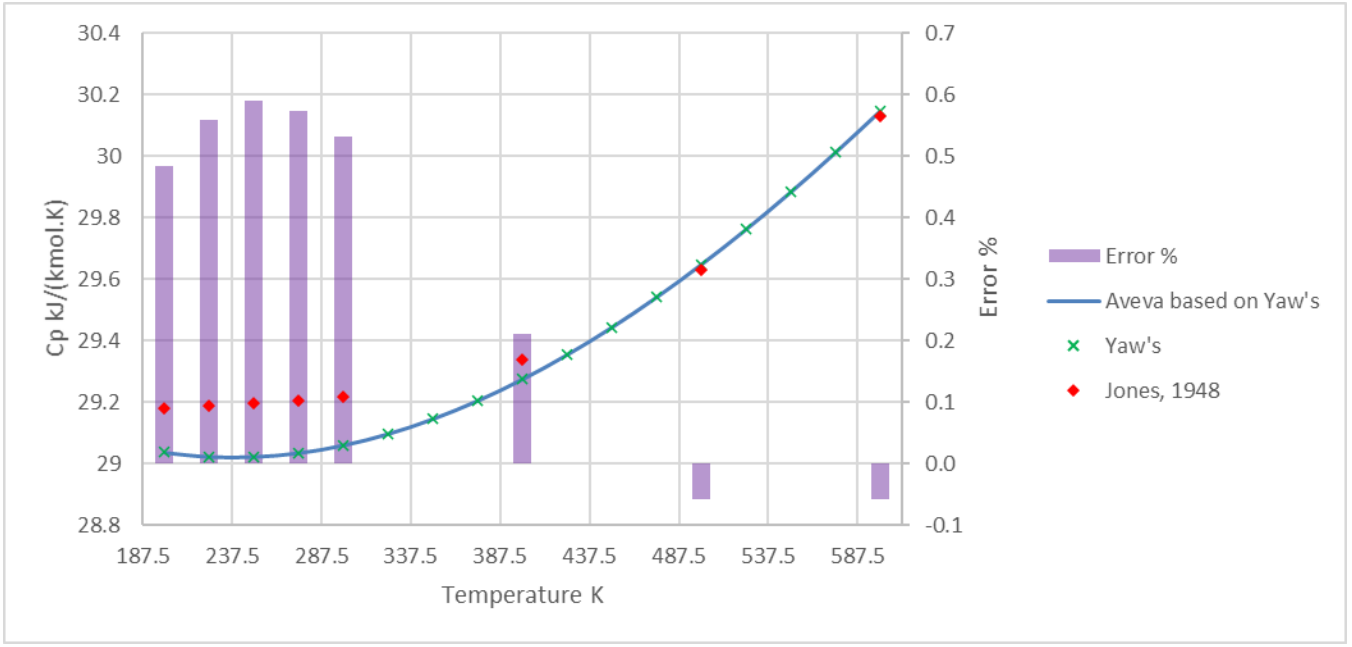
Thermodynamics:

- Tritium doesn't exist! (in traditional databanks)
- Properties are not easily available
- Process includes high temperatures and extremely low pressures

Solution:

- User databanks and components easy to build, property regression
- Support from AVEVA team to bulk output thermo data for validation





Modelling unusual processes requires unusual solutions

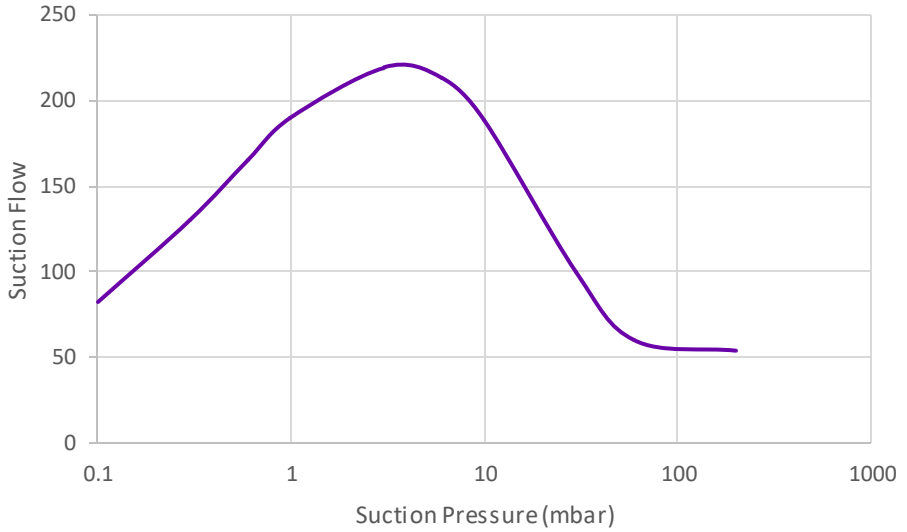
Equipment:

- Turbo-molecular pumps use a completely different operating principle
- Scroll pump curves don't fit "traditional" compressor models
- Hot palladium hydrogen membranes are very specific

Solution:

- Custom models from correlated vendor performance graphs
- Palladium membrane model available

Image courtesy of wikimedia.org



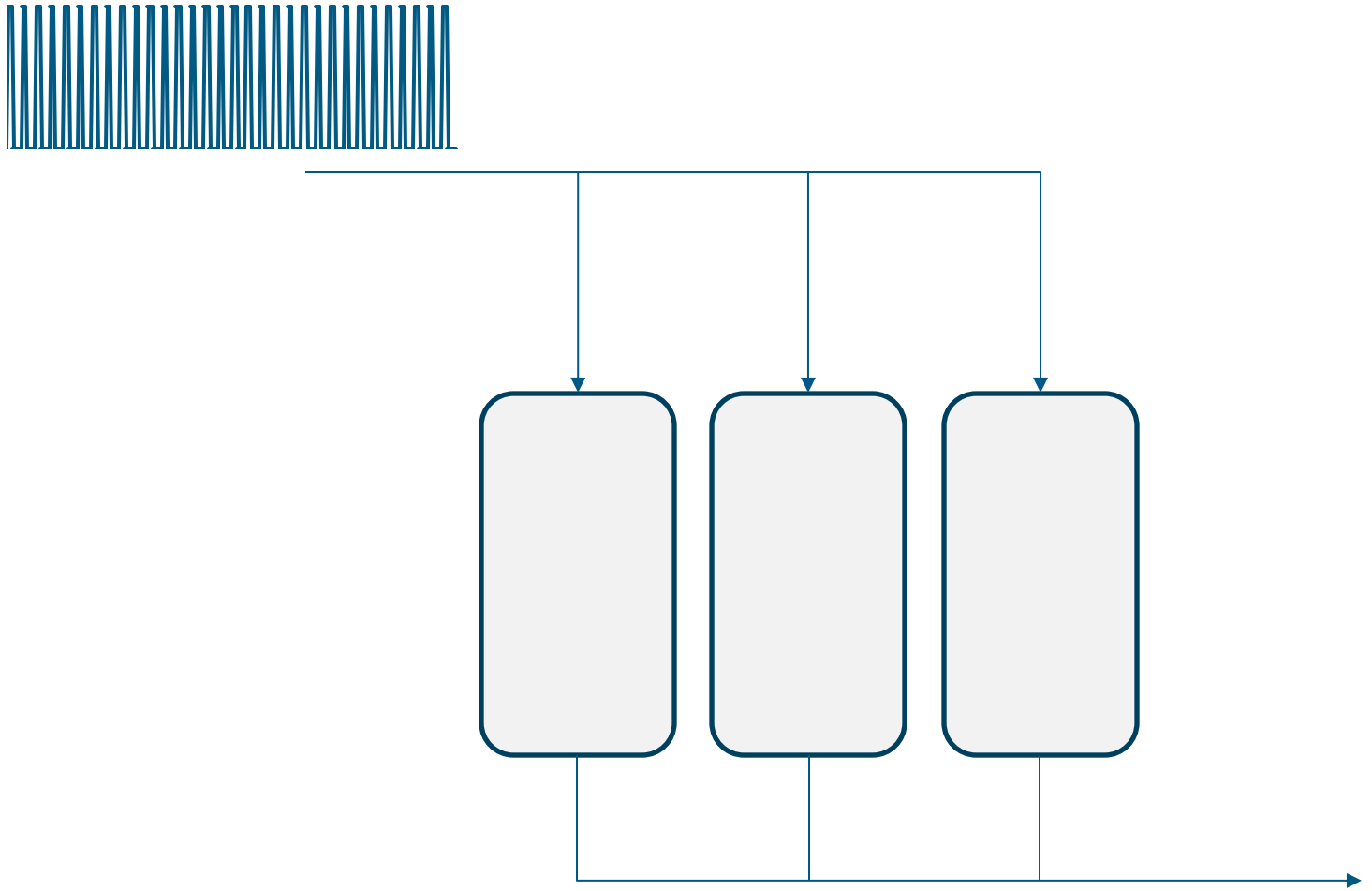
Modelling unusual processes requires unusual solutions

Process Logic:

- Pulse schedule and the gas purge cycle run simultaneously, but decoupled
- Holding times, lockouts, automated impurity dosing, and threshold triggers require intricate logic

Solution:

- Scenario manager allowed us to generate event schedule for pulses
- Equations and logic functions connected to valves and pumps created independent cycle sequence



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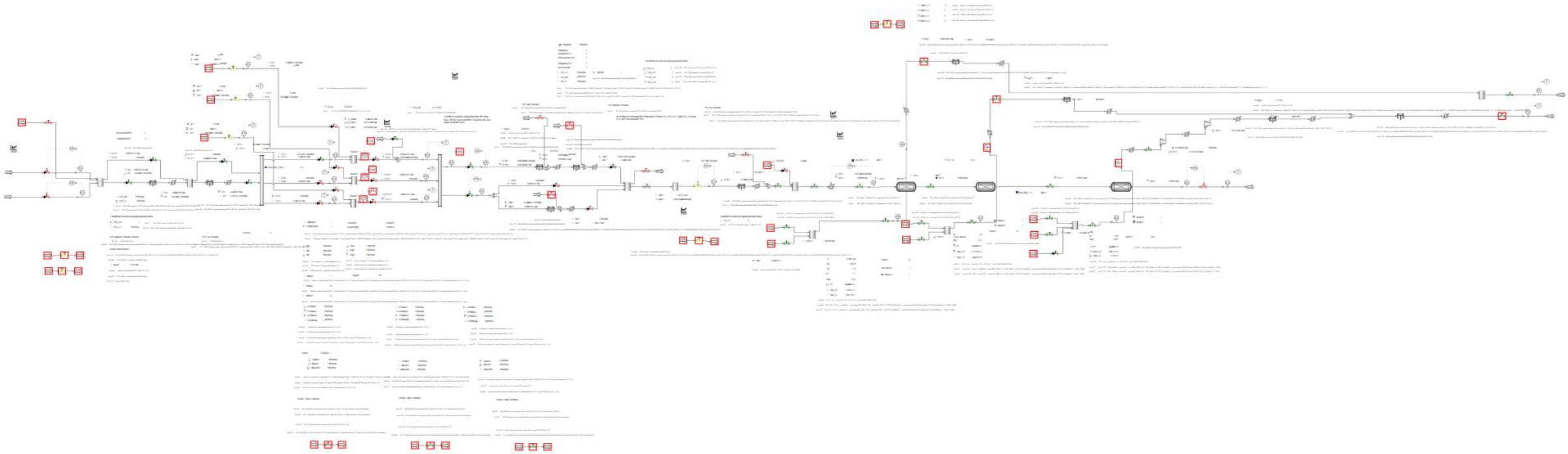
Much of the modelling happened outside the process



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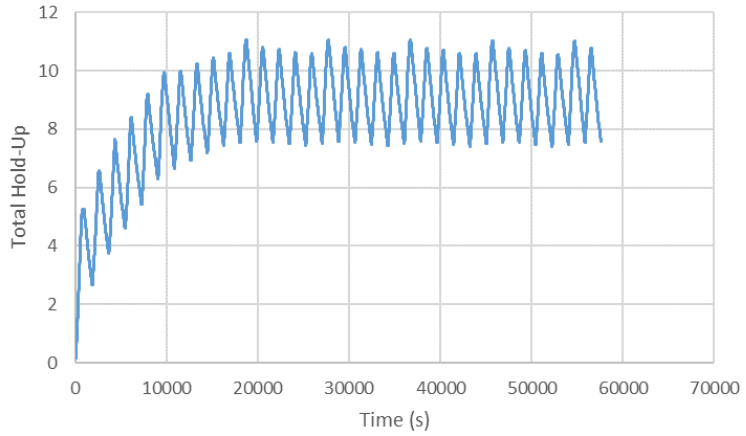
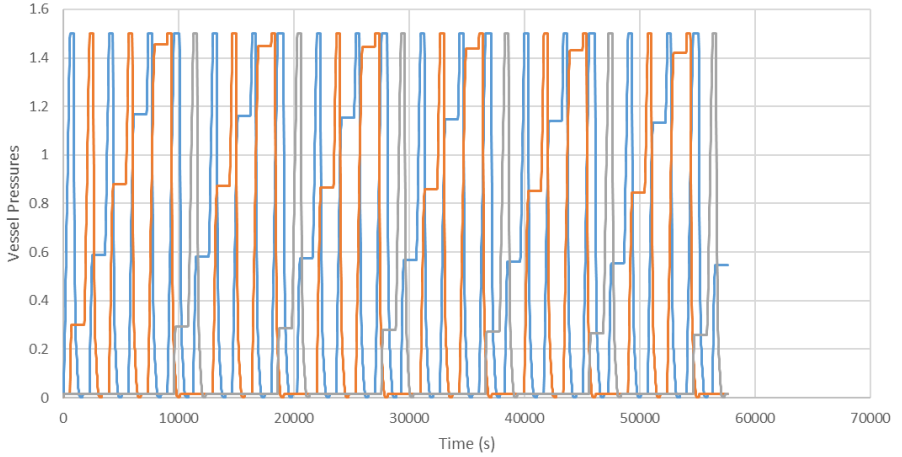
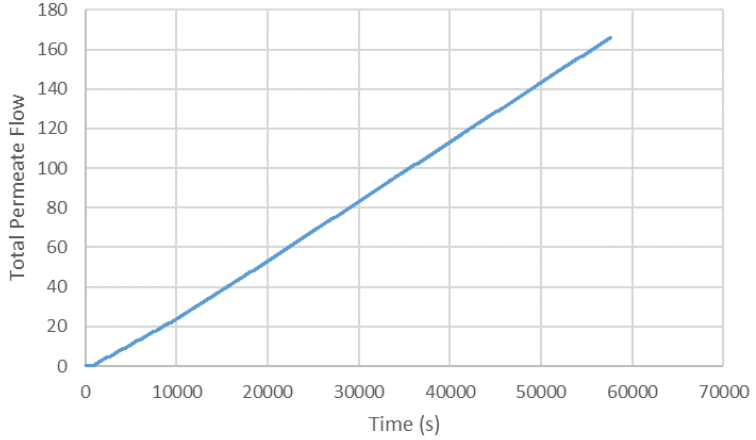
The Outcomes

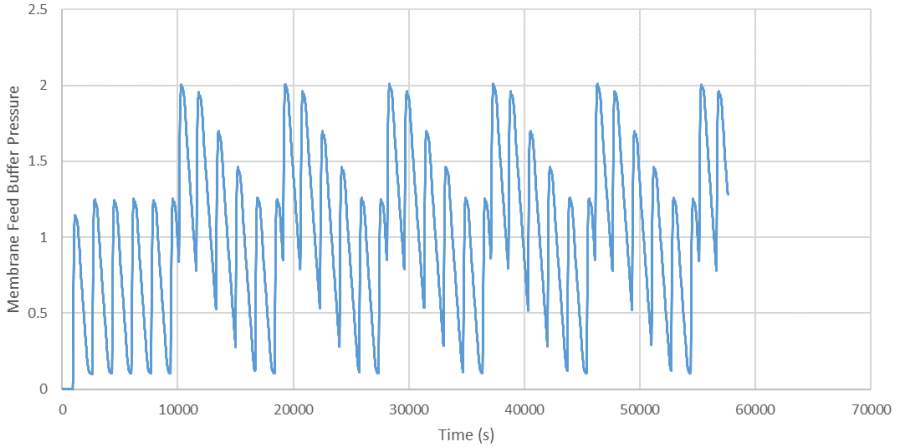
Project successes, and new ways of working

Early dynamic modelling informed the process design

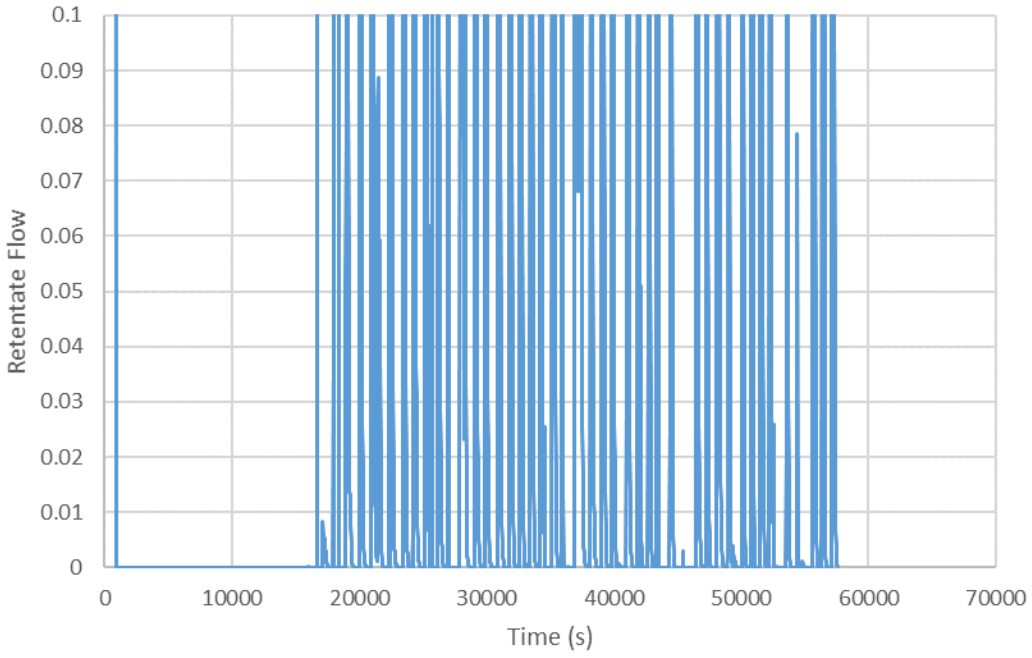


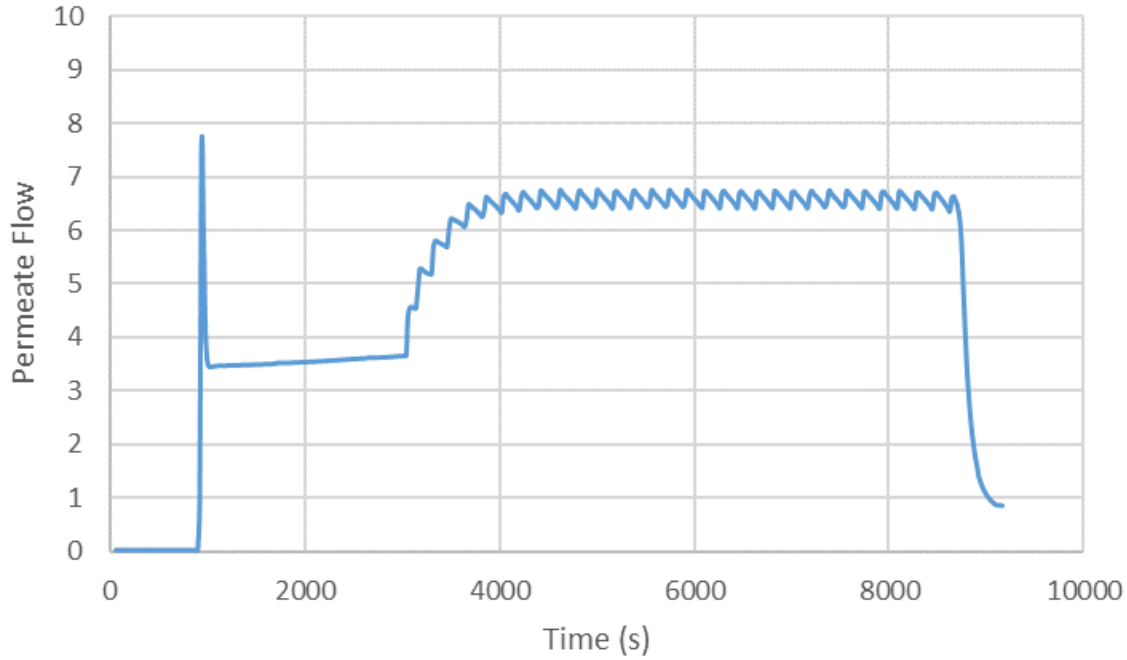






Obtaining the dynamic profiles improved the control scheme





Summary

Dynamic modelling required very early in project

AVEVA Process Simulation custom modelling essential for models with very unusual equipment

Specifying any variable allowed model to be built with mix of equipment data and design specs

Dynamic model built project team's understanding of system behaviour:

- Captured interaction of sequencing, control logic, and equipment selection
- Confirmed equipment sizing and overall design
- Revealed sequencing issues early
- Established pressure profile, equipment limits
- Improved control scheme
- Supported hazard study scenarios (inventory tracking)

Questions?

Please wait for the microphone.

State your name and company.

Please remember to…

Navigate to this session in the mobile app to complete the survey.

Thank you!

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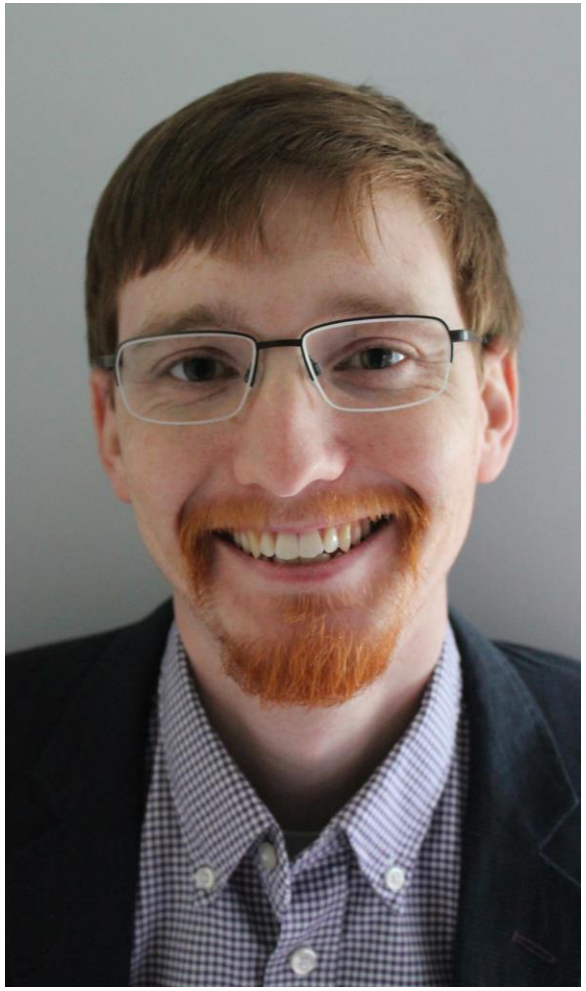

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