Engineering
DIGITAL TWINS

# JNEM - thermal-hydraulic loop

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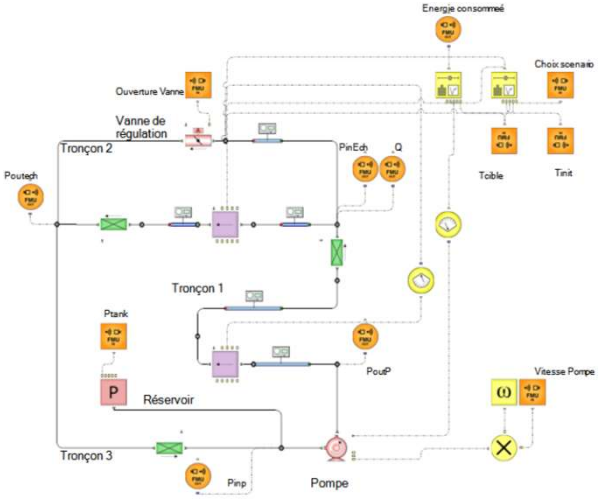
## Physical Twin description

- Closed & instrumented hydraulic loop, equipped with a pump, a heat exchanger, a tank, a regulation valve and three piping sections,
- Provides flow, pressure and/or temperature requested by the operator.
- Several control devices added to generate some defects artificially

## Digital Twin Description

Existing baseline / new developments forecasted




## Digital Twin usages

- Detect, localize, and estimate variations in process parameters (flow, pressure, temperature) through comparison with measurements at several locations of the physical system
- Optimize the process loop settings (pump speed, valve opening) to reach target process parameters (flow, pressure, temperature) according to operator requirements (reactivity, , energy consumption…) thanks to the simulation of different scenario using the digital twin + direct (or through operator) actuators driving according to the “best scenario”.
- Provide monitoring and prediction capabilities: use of virtual sensor to estimate and predict process parameters, such as flow rate (in the event of a flow meter failure), allowing for real-time monitoring and control of the physical system

## Engineering Digital Twin challenges

- Data collection when physical measurement are difficult/impossible (system availability, system damage risk, time consuming). Data and physic-based **models hybridization** are required: how to operate this hybridization?
- Sustainability and **Modularity** of DT design: reduce the number and size of models, reuse models and codes, recycle old models, define strategy/tools for application to other loop configurations i.e. required sensor number, position and accuracy + Modularity + Composability)
- How to manage the **life cycle** of the DT? MBSE + DevOps approach?
- Measuring alignment between physical asset and DT: Definition of update frequency and/or trigger threshold?
- Possible application of Physical system partial control by the DT (**Coupling**).
- **Interoperability** between 2 digital twins (DT of the loop + DT of a loop component (valve for example)). How can we get the two to talk to each other? Using which standards?

Reference publication https://asmedigitalcollection.asme.org/IDETC-CIE2025