Creation of a Test Bed for an SMR Emulator Supporting Data Acquisition

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Abstract

Small modular reactors (SMRs) have gained interest as potential source of clean and efficient nuclear energy. To support SMR research and development, a testbed of a SMR emulator was created to collect temperature and pressure data to support development of a digital twin. The system utilizes thermocouples, pressure transducers, and a LabVIEW data analysis interface to monitor, interpret, and control the system in real time. Data collected from experimental tests will be used to develop a Simscape model, providing a digital twin for future SMR simulation and analysis

Methods

- LabVIEW was used for data collection, interpretation, and control over the loop using the proportional valve.
- Simscape is being used to create a digital twin of the loop using data and tests collected through LabVIEW and running the system.
- A 3D model of the loop was created through Fusion and then uploaded to Inventor for display and viewing on the main monitor in the loop control room.

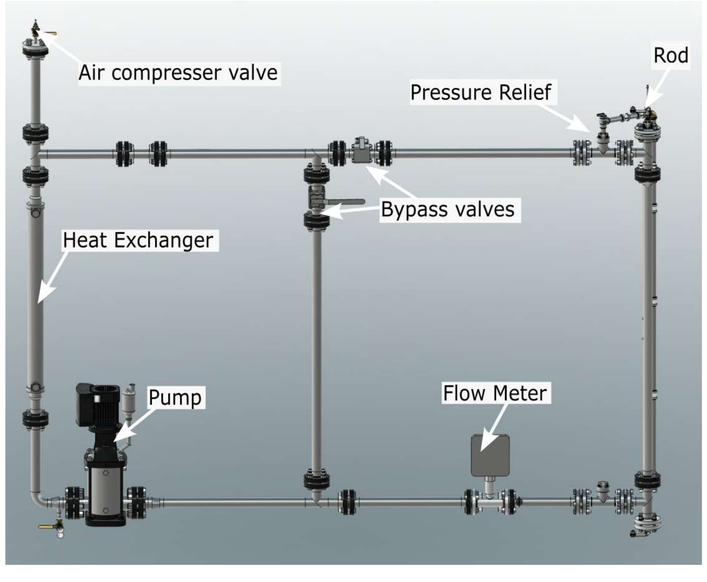

Figure 1: A 3D model of the testbed loop used in the experiment

Sensors and physical adaptations

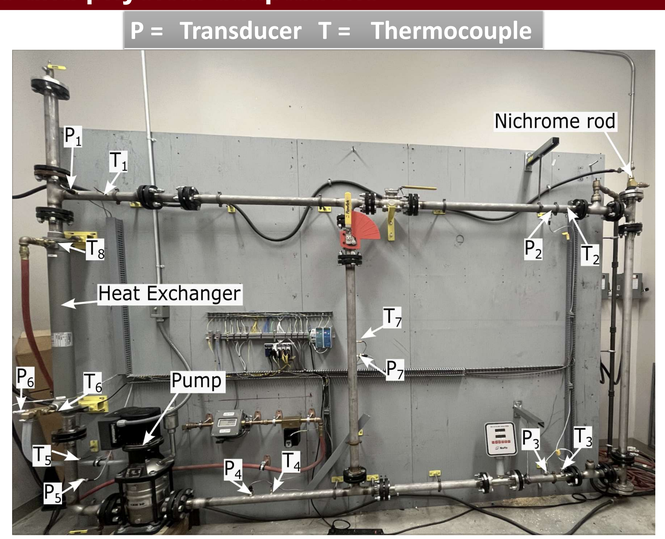

Figure 2: Physical testbed loop with sensors and import parts labeled

- Integrated 8 type K thermocouples and 7 pressure transducers throughout the SMR emulator
- Sensors monitor temperature and pressure across the loop
- Data is collected using National Instruments DAQ and visualized in LabVIEW
- Experimental data will be used to help create a Simscape digital twin

Goals and next steps

- Conduct tests with varying voltages to characterize thermal and pressure response
- Have a fully automated and controllable system for tests
- Complete optimization of the LabVIEW control interface
- Complete a Simscape model of loop that mimics the testbed
- Use the data collected in tests to get constants for the Simscape model to create a more accurate digital twin
- End goal of having a completely accurate digital twin of the SMR emulator testbed.

Conclusion

- Successfully created a LabVIEW based data acquisition system that updates graphs and controls the system in real time
- Integrated 8 thermocouples and 7 pressure transducers across the test bed loop for monitoring and data
- Established the experimental foundation for obtaining data to improve the development of a Simscape digital twin
- Future developments will focus on automating testing and model accuracy and calibration

LabView and Data Collection

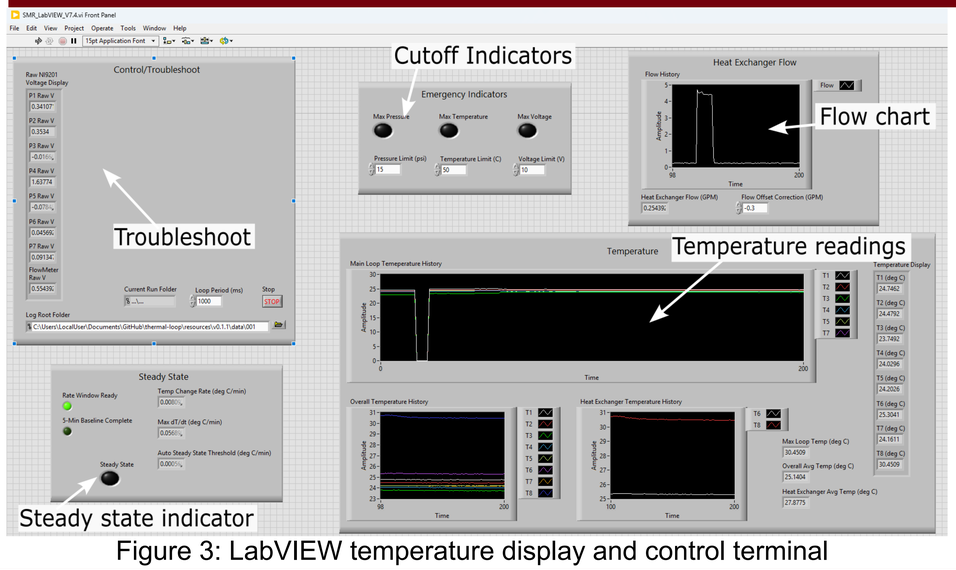

Figure 3: LabVIEW temperature display and control terminal

- Developed a LabVIEW interface for real-time monitoring and control of the SMR emulator testbed
- Obtains and displays temperature and pressure data from all 15 sensors through a National Instruments DAQ.
- Has an automatic fail safe of opening the proportional valve to cool the system when the user-defined temperature limit is exceeded
- Calculates the rate of change of temperature (dT/dt) to identify when the system has reached steady-state
- Experimental data is recorded onto excel files which are used for analysis and future validation for the Simscape digital twin development

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