

Memo on Validated and Test models for well integrity monitoring, subsurface temperature monitoring and predictive maintenance

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Disclaimer: deliverables D2.1, D2.2, and D2.3 of the Nieuwe Warmte Nu! GEMINI project contain or discuss developed models that have been delivered to the consortium members as a formal project deliverable via a shared access link to the project Github: <https://github.com/GEMINI-Digital-Twin>. All partners currently have access to the repository. At this stage, the models remain restricted to consortium partners; however, they are planned to be released as open-source in a subsequent phase, after which the public open-source version will become the primary reference for all further development beyond the current closed repository.

Overview

The integration of Digital Twin technology into a low-enthalpy geothermal plant represents a significant advancement in real-time monitoring, predictive maintenance, and overall operational efficiency. The focus of the Nieuwe Warmte Nu! (NWN) project is to develop and implement a Digital Twin for deep geothermal plants (doublets). This will enable monitoring and simulation of plant operations, allowing for performance optimization, optimized maintenance planning, and risk mitigation.

Deliverable D2.2 of the project consists of validated as well as test models for well integrity monitoring, subsurface temperature monitoring and predictive maintenance. As this deliverable consists of code, this document primarily serves as a reference document accompanying the code deliverable, which has been provided in the form of a .zip file containing all the work completed as of the writing of this document at the end of Work Package 2. At a later point in time, this code will also be available through the open-source release of the GEMINI digital twin on the project's Github page: <https://github.com/GEMINI-Digital-Twin>.

The next section provides a high-level overview of the contents of the zip file provided alongside this memo. For a full, detailed description of the models as well as their integration into the GEMINI digital twin framework the reader is referred to Deliverable 2.1 of the project, which is a report on the implementation of the models, modules, and applications in the GEMINI digital twin.

Description of the code structure

The code accompanying this deliverable is given in the form of a zip file called “gemini_model.zip”. When unzipped, the provided file will contain the following structure:

- The main folder containing the “model_abstract.py” file, the “readme.txt” file, and a number of other folders. The abstract file contains the template structure that every model needs to adhere to in order to be able to connect to the rest of the digital twin framework. The “readme.txt” file provides a disclaimer indicating that any future publications of GEMINI models supersede the models in the zip file.
- A folder named “corrosion”. This folder contains all the models relevant for the (CO₂) corrosion modelling done in the digital twin, including partial pressure, De Waard-Lotz-Dugstad, De Waard-Lotz-Milliams, and Norsok correlation models.
- A folder named “fluid”, containing a model that provides relevant fluid properties of geothermal brine, including the Batzle-Wang correlation that is used to update the density and viscosity of the brine based on temperature, pressure, and salinity.
- A folder named “pump”, which contains the model of the Electrical Submersible Pump.
- A folder named “reservoir”, containing models for the inflow performance of the reservoir.
- A folder named “well”. This contains the models for the wellbore pressure drop for a number of pressure drop correlations. This includes the single phase Swamee-Jain and two-phase gas-liquid Beggs and Brill correlations. In addition it also includes a model for calculating the temperature drop as a result of heat loss to the external environment along the wellbore.