Public progress report year 1

Project title: DRAG Reduction in Geothermal & District Heating systems to LOWer investment and operational costs - DRAGLOW

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Background

The energy transition to reduce CO2 emissions is both a technical and public challenge. Natural gas will be replaced by low carbon heat supply. District heating is a proven concept and these systems are expected to fulfill 50% of the thermal energy needs of buildings in the Netherlands. Integrated geothermal multi-source district heating can deliver low-carbon heat to the built environment. This proven concept is simple and robust but require major investments with low returns. The main challenges are to reduce cost of infrastructure and operations, and minimize environmental impact. As water is the medium to be circulated to transport heat through the system, high pumping power is required to overcome flow resistance in pipelines. Additionally, to control flow resistance pipe diameters must be increased, raising infrastructure costs. Reducing flow resistance or drag is possible using so called Drag Reducing Agents (DRA's), currently primarily used in the oil and gas industry. Adding low concentrations of DRA molecules to the water can significantly reduce flow resistance, allowing pipe diameters to be considerably smaller (CAPEX) and lowering the required pumping power (OPEX).

Goal

The goal of this project is to assess the techno-economic viability of DRA's for geothermal multi-source district heating networks. The project investigates the technical and economic contribution of DRA's to district heating networks and geothermal wells. The DRAGLOW project focuses on the development of technical knowledge and system design tools which should lead to practical usable solutions and instruments for cost-effective geothermal Multi-Source district heating systems in the built environment. Preliminary analysis revealed that substantial reduction in CAPEX and OPEX is feasible by controlling the flow resistance in the pipelines and all subsystems of the district heating system. If the flow resistance can be reduced substantially, 20-30% cost reduction is within reach. DRA's lower the pumping and construction costs in oil pipelines by reducing the friction between the oil and the pipe surface. This concept triggered the idea to apply such agents in the very cost driven geothermal and heat network systems. Several groups of molecules have drag reducing properties depending on the conditions such as liquid composition, temperature and Reynolds number.

Partners

The project partners cover the whole supply chain in the district heating and geothermal sector.

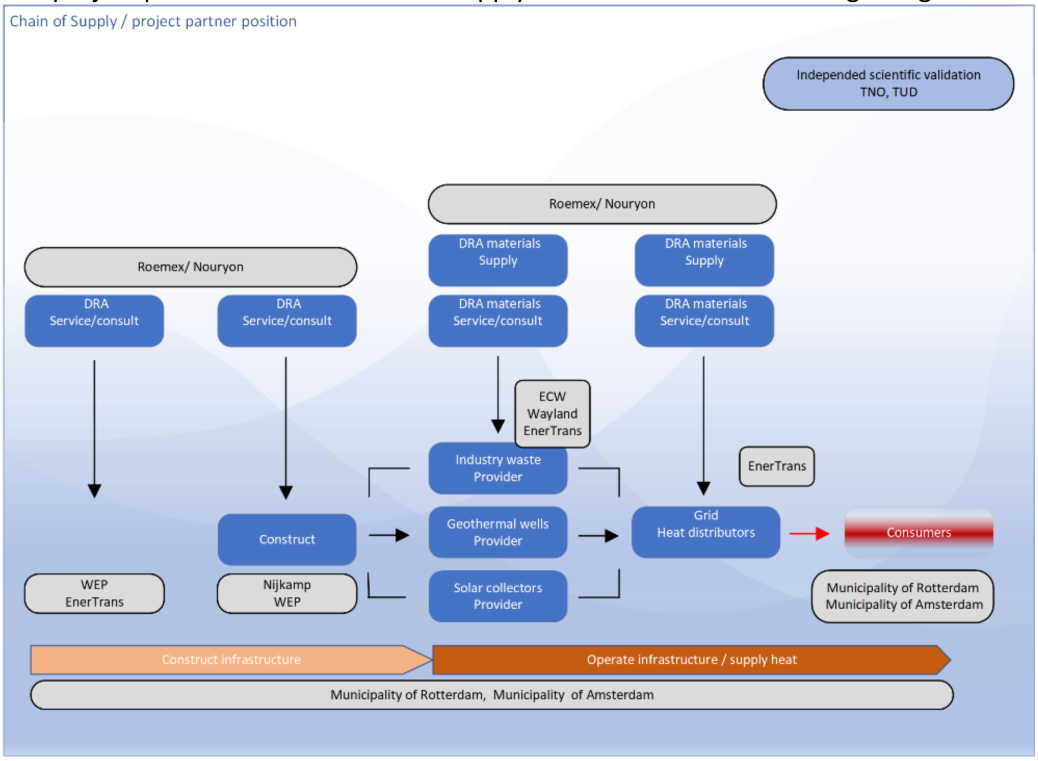

Figure 1 – Project partner position in the supply chain.

A list of the partners and their role in the project is given below.

ECW: End user, geothermal producer greenhouse grid operator, expert system & operational requirements, provide production and system design, geophysical production data. Co define experimental research program.
Wayland Energy: End user, geothermal producer greenhouse grid operator, expert system & operational requirements, provide operational data. Co define experimental research program.
Gemeente Rotterdam: Contribute with expertise public project requirements, regulation procedures, development frame work regional projects. Knowledge share
Gemeente Amsterdam: Contribute with expertise public project requirements, regulation procedures, development frame work regional projects. Knowledge share
EnerTrans: District heat system developer, end user, heat producer, grid operator, distributor. Consultant development of district heat project. Developer of DH system design models and engineering assessment models.
Well Engineering Partners: Expert design & engineering of geothermal wells, provide design expertise contribute to well design model development, engineering and geo-physical design data.
Nijkamp Aanneming: Expert engineering of district grid construction, provide test materials and co define experimental research program
Roemex Ltd: Supplier of DRA products, expert consult chemical for petrochemical and geothermal operations, operational requirements, international standards and regulations. Conduct detailed supplement laboratory measurement.
Nouryon: Supplier of basic DRA products, expert consult DRA (organic) polymers and surfactants, detailed measurements in lab analytical instruments, twin flow tests, test materials,.
TU Delft: Research organization. Basic research (post doc) and experiments to investigate DRA reservoir compatibility.
TNO: Research organization, Penvoerder: Project coordinator Experimental research investigate DRA performance for district heat and geothermal systems in large scale flow loop(s).

Performed activities, obtained results and foreseen applications

Result1 - DRA material selection

An extensive literature survey, data collection and interviews were performed to collect relevant system requirements for both geothermal and district heating systems. The outcome of the system requirement definition was presented in a workshop to the consortium members to finalize the system requirement. The results of the workshop were disseminated in a newsletter.
A diverse set of DRA are selected (surfactant, polymers and biopolymers) which are being tested under different salinity and temperature conditions. The short and long term stability and degradability of these materials are being investigated together with their characterization under geothermal and district heating conditions. The outcome of the pre-screening will provide inputs for the DRA's to be tested later in the project and will map the compatibility of the existing DRA for different geological and district heating conditions (shallower systems, lower temperature, district cooling, etc.).

Result2 - DRA performance assessment in the heat production and transport system

A setup requirement and capability document was prepared based on the system requirements. Two concepts were developed (either using pumps or pressurized vessels to mitigate the degradation). In addition due to the difficult conditions of the flow loop, a thorough corrosion investigation of the flow loop was performed and documented. The first concept based on pumping is finalized and parts are currently being ordered: vessels, pumps, controllers, etc.

Result3 - The effect of DRA's on well injectivity

A review of the existing models for the transport of DRAs in porous media has been carried out, focusing on standard models for polymer injection in porous media.
The software packages to be used for the modelling have also been reviewed and were selected.
An initial set-up of the polymer models have been made. Preliminary core-floods have been carried out to obtain baseline results and determine the final configuration of the core-flood set-up. This includes the relevant test conditions and measurement parameters.
Multiple DRA samples have been received. Their rheological properties are being measured to determine the best concentrations for future core-flood tests.

Result4 - Simulation models, DRA parameter implementation

The team has been able to gather a whole lot of area information of the reference project. Data has been received from different sources like the municipality, housing associations, public available databases. The data has been assessed by the team and integrated in the hydraulic network model. The team integrated the data in the hydraulic model and developed a reliable base reference model for this area. A typical area district heating project roll-out does require pre-installation and over dimensioning of network piping. The team managed to build a flexible phased model to assess the minimum and maximum network diameters in time with a interaction with the techno-economic model(s) from Result 6. Next challenge is to develop the hydraulic model on the technical results and specifications of DRA's. The team is working towards the stage where they want to create scenario's to simulate Non-DRA vs DRA System. To achieve this, a significant change in the modelling tool is necessary.

Result6 – Techno-economic benefits of applying DRA

In Result 6 we are focusing on the techno-economics benefits of the drag reducers. It's our goal to have an integrated project approach where we are able to asses both the production and the grid part of the project. Our first milestone was to gather as much as possible financial models which are used for both geothermal as district heating grids. The DRAGLOW team has made a significant effort to collect data and financial models. The team did manage to gather seven different financial models and accompanying results, two geothermal models and five network models. We did asses and analyze these models on input, output and results. We did start the process to access the possibilities to integrate a geothermal and network model.

Contribution of the project to the goals of MOOI

The developments in the gas-free neighborhoods, i.e. aardgasvrije wijken, requires a significant transition from fossil-based heating systems to sustainable sources. Geothermal energy can play a significant role in the energy transition and is expected to grow rapidly in the coming years. The Masterplan Aardwarmte, a roadmap for the future of geothermal energy in the Netherlands, suggests that geothermal energy could grow to supply 5% of the total Dutch heat demand in 2030 and 22% of the total heat demand in 2050. However, in order to achieve these goals, the number of geothermal wells requires to grow to 175 in 2030, and 700 geothermal wells in 2050. Currently around 22 geothermal wells have been drilled, indicating a significant growth required to achieve these plans.

Additionally, it is expected that new DH systems will be developed in a near future to connect geothermal and other heat sources to dwellings. The cost effectiveness of geothermal energy deployment and sustainable heat transport with the current technologies is marginal, both on the capital and operational expenditure (CAPEX and OPEX). Currently the wells and heat network pipelines are installed with a relatively large diameter to deliver a higher flow rate and thermal power dictated by the heat demand. The cost and emission associated with the manufacturing, drilling, installing and operating current systems are crucial factors in further developments of sustainable heat supply and transport. Smaller diameter wells are cheaper to drill with a lower CO2 footprint considering the manufacturing and drilling process, approximately 15-20% cheaper than a conventional diameter well, and in the mindset of the 700 well target set for 2050 this could result in a CAPEX reduction of 500 million to 700 million euros.

However, production and transportation from smaller diameters pipelines to meet the same heat demand would require an enormous power for the pumps to supply and transport the thermal energy leading to a higher OPEX. An extensive infrastructure for the heat networks is required to be developed including kilometers of pipelines with several pumping stations. Additionally, power consumption by the pumps for the production and transport of the sustainable heat has a significant impact on the OPEX of these systems and needs to be optimized.

An integrated approach to reduce OPEX and CAPEX, defined as the integral cost, of geothermal heat production and distribution could accelerate the role of sustainability in meeting the heat demand. This project aims to provide a novel system solution for making the collective heat and cold supply more economically competitive as well as sustainable and improve spatial integration of DH systems. The focus of this project is on employing environmentally friendly drag reducing agents coupled with the system design to minimize the integral cost. The current project is envisioned to reach the following outcomes:

- Reduction of investment CAPEX (aim - 20% to 30%)
- Reduction of operational costs OPEX both (aim -15% to 30%)
- Provide fit-for-purpose solutions, including geothermal well and DH system with reduced diameters, by the product and service providers for the sustainable heat supply sector.
- Novel approaches for chemical injections aiming at cost reductions in the geothermal doublets and DH systems.

Publications

Updated information about the project can be found on the website Home | Mijnsite 1 (draglow.nl), TNO - Innovation for life - Zie het voor je | TNO and Stichting Warmtenetwerk: Eerste resultaten DRAGLOW-project - Stichting Warmtenetwerk
In December 2021 the first Newsletter has been published.
Scientific publications are foreseen from middle of 2022 and beyond.

Further information

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