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This Vacuumized pipe-in-pipe Solution for Efficient Geothermal Heat Extraction Everywhere

K. Maver, C. Hanna, and O. Vestavik
Green Therma

KEY TAKE-AWAYS

• Using proven oilfield technology, the co-axial completion with a vacuumized inner pipe can significantly reduce the heat loss of the water returning to the surface.

- Maintenance of the system is very limited for the entire 50-100 years of lifetime. This is due to no moving
- downhole equipment and the closed-loop nature.

• The solution has a near global application due to its very limited geological requirements.

• The high temperatures delivered on the surface eliminates the need for further boosting with heat pumps.

- The solution gives a diverse usage directly for district
- energy and industrial processes. And by reversing the flow, heat

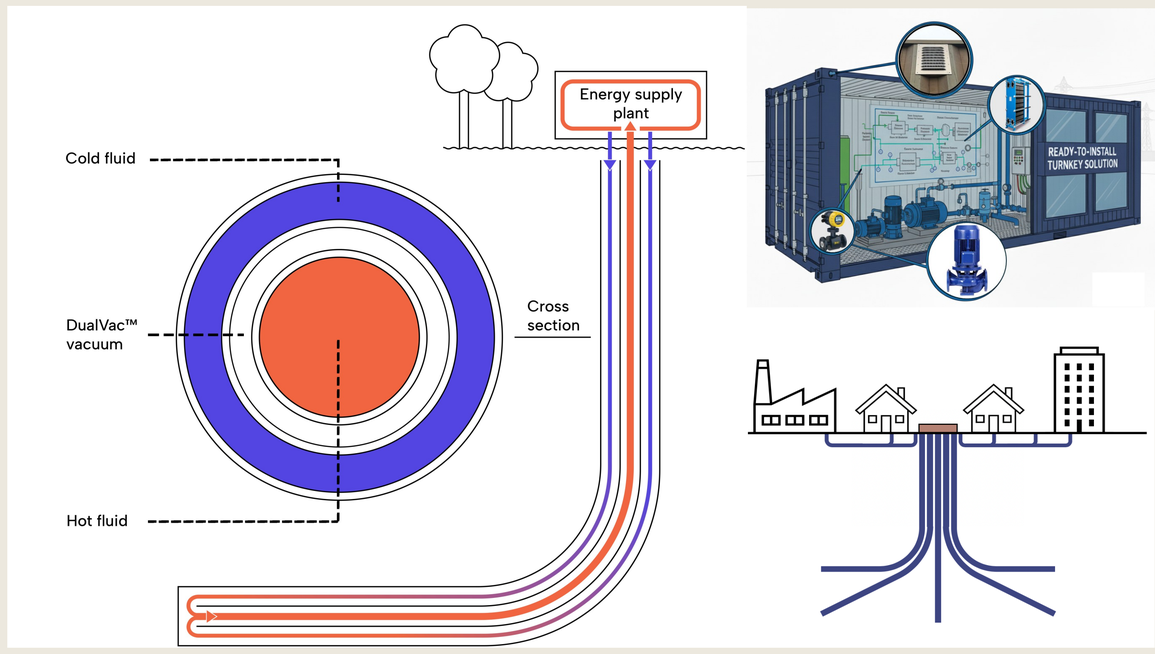


Figure 1

A: Closed-loop co-axial horizontal geothermal well solution.

B: 20-foot surface container with the equipment required for one well.

C: Geothermal multi-well facility supplying a city or an industry with heat.

CLOSED-LOOP CO-AXIAL GEOTHERMAL WELL SOLUTION

The well is drilled to a depth of 3-5 km with a 2-5 km slanted or horizontal section. This makes it possible to reach the temperature (100-150° C) required for producing sufficiently heated water (Figure 1A).

A circulating fluid flows in the outer pipe of the well with no contact to the geological formations. In this process, the fluid is heated up along the horizontal section to the approximate temperature of the subsurface before returning to the surface in the inner insulated pipe with a continuous vacuum (Figure 2). The vacuum nearly eliminates the heat loss as it acts like a thermos flask compared to a standard solution, which loses 30-40% of the heat on its return to the surface.

The closed-loop solution eliminates corrosion risks, and the installation has a lifetime of 50-100 years. The geological risk is nearly eliminated. The well constantly produces thermal energy, with the possibility to adjust the output during the year.

The solution benefits the environment. It has a miniscule surface footprint corresponding to a 20-foot container for the topside-facility, and a limited electricity consumption for a small circulation pump (with no risk of subsurface fracking and ground water interference) (Figure 1B). A geothermal facility can be completed with one well, but will often be completed with 5-10 wells for 10-25 MW (Figure 1C).

Due to the limited geological requirements, the solution has a near global application. A well will always produce thermal heat. However, the actual output may vary from the modeled output due to uncertainty about the subsurface temperature and the thermal conductivity of the rock especially where the horizontal section is placed. The final parameter that impacts the project commerciality is the rock type, which can significantly impact the drilling speed and therefore the number of days for which a drilling rig is needed (Figure 3).



Figure 2. Vacuumized pipe-in-pipes pre-assembled in lengths of 10 m, assembled on the rig floor and then lowered into the well completion.

DIVERSE USAGE

With high temperatures delivered on the surface no temperature boast is required the system has a diverse usage (Figure 4).

• District heating: The temperature and MW energy output makes the solution ideal for direct use in district heating. Only a heat exchanger is required to deliver heat directly to the end user. District heating is widespread especially in Europe and worldwide for military bases and university campuses and medical centres.

• Industrial applications: Enormous potential to supply heat directly for recreational usage, in the agriculture industry (green houses), and for industrial processes (breweries and dairies).

• District cooling: Works according to the same principles as district heating by circulating a cold fluid in a district grid to buildings using an absorption chiller with better energy efficiency than existing cooling solutions and frees up much -needed space in urban areas.

• Desalination: 1.5–2.5 MW heated fluid is sufficient to directly drive thermal desalination processes such as a Multi-Effect Distillation (MED) and produce 2,400 to 4,000 m3 freshwater/day.

• Electricity generation: With flow rates of 5-15 l/s and the subsurface temperature target, the closed-loop well is more suitable for thermal production than for electricity production even though it is possible using an ORC.

• Heat storage: If energy is available to heat the working fluid in the closed-loop well to a significantly higher temperature than the existing temperature along the horizontal well section, it would be possible during part of the year, when there is no application for the heat, to reverse the flow to reheat the subsurface for later harvesting.

Figure 3: Three main parameters impacting the commerciality of a closed-loop geothermal well.

Figure 4: Diverse application of the direct use of geothermal heat in the long-term sustainable temperature range of approximately 70-120° C.

REFERENCES

Maver, K. G., 2025: Vacuumized Pipe-in-Pipe Solution for Efficient Geothermal Heat Extraction Everywhere for District Cooling and Heating and Industrial Usage, Proceedings, 50th Stanford Geothermal Workshop, Stanford, USA.