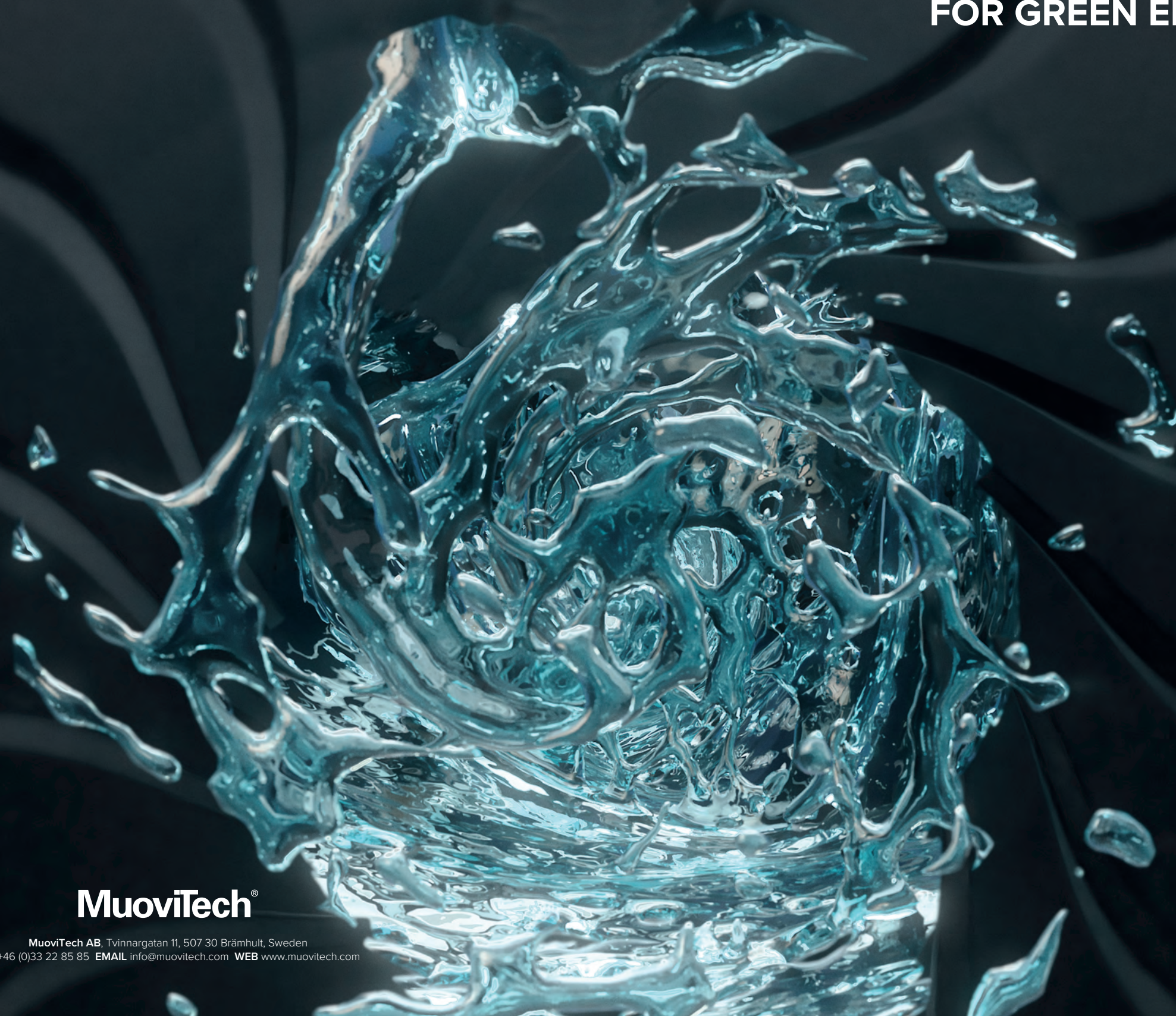


TURBOCOLLECTOR®

EXPECT EXCELLENCE

TURBOCOLLECTOR®

**THE OUTSTANDING PROBE
FOR GREEN ENERGY**



MuoviTech®

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SCIENTIFICALLY SHOWN ENERGY SAVINGS WITH THE TURBOCOLLECTOR

MUOVITECH'S PATENTED FIN DESIGN IS OPTIMISED FOR IMPROVING HEAT TRANSFER AND GEOTHERMAL SYSTEM EFFICIENCY

FINS INSIDE

ROTATION BACK AND FORTH



TURBULENT FLOWS AT SIGNIFICANTLY LOWER FLOW RATES

Turbulent flow increases the heat transfer to the collector fluid. With the turbo collector, turbulent flow is induced at 22% lower flow rates than a conventional collector (1,800 Reynolds vs 2,300 for conventional collectors)

UP TO 11% INCREASE IN COP

Simulations show the TurboCollector reduces the convective resistance with up to 80+%, increasing the collector fluid temperature and COP of the heat pump

ELECTRICITY SAVINGS YEAR AFTER YEAR

During 50+ years of collector lifetime, the TurboCollector will continuously reduce electricity consumption, saving money and CO2

CERTIFIED PRODUCTS

The TurboCollector comes with all relevant approvals, depending on your local market (P-marking and SKZ)

AVAILABLE IN ALL RELEVANT DIMENSIONS AND PRESSURE CLASSES

Single or double collectors, 25mm, 32mm, 40mm, 45mm, 50mm and 55mm

Also available in MuoviTech's patent pending elliptical turbo design: MuoviEllipse

MAXIMISES THE HEAT TRANSFER

Muovitech's fins with alternating pattern maximises the heat transfer by initiating turbulent flows at lower flow rates than conventional collectors

HOW IT WORKS

HIGH HEAT TRANSFER EQUALS TO LOW BOREHOLE THERMAL RESISTANCE

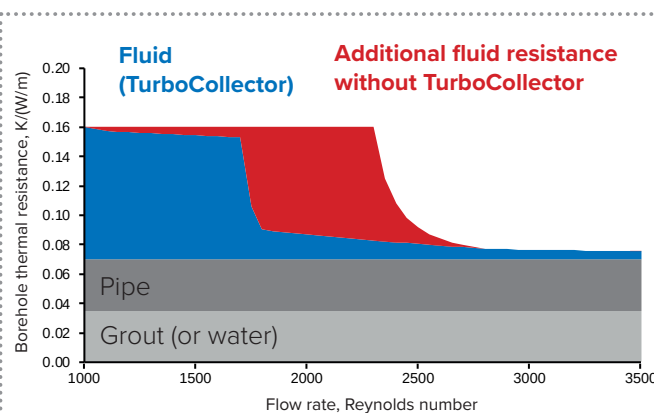
The efficiency of a geothermal system is explained by the level of borehole resistance. The lower the thermal resistance, the easier it is for heat transfer from the ground to the heat pump. Therefore, a low borehole resistance is crucial for a well performing geothermal system.

CREATING TURBULENT FLOW SIGNIFICANTLY REDUCES THE BOREHOLE RESISTANCE

Typically, the biggest contributor to borehole resistance comes from the collector fluid when the fluid flow is laminar (at lower flow rates). Therefore, it is ideal to achieve turbulent flow, which reduces the overall resistance with around 50%.

THE TURBOCOLLECTOR INITIATES TURBULENT FLOW AT 22% LOWER FLOW RATES

With a conventional collector, the transition towards turbulent flow starts at flow rates around 2,300 Reynolds. However, with Muovitech's TurboCollector, the optimised fin structure initiates transition to turbulence at 22% lower flow rates (around 1,800 Reynolds).



HIGHER COLLECTOR FLUID TEMPERATURE

With the reduced borehole resistance from turbulent flow, the temperature of the collector fluid increases, which improves the COP of the heat pump(1).

THE TURBOCOLLECTOR HELPS THE SYSTEM TO BECOME MORE EFFICIENT

With the TurboCollector, turbulent flow can be achieved in a larger range of flow rates. Most modern heat pump systems operate with variable flow rates during the seasons to match variable heating (or cooling) demands. This means that a typical system will always benefit from the TurboCollector compared to conventional collectors.

1) For heating running conditions. Conversely for cooling conditions, the collector fluid temperature is reduced which then also improves COP of the cooling applications.

THE DIAGRAM ILLUSTRATES THE TYPICAL BOREHOLE THERMAL RESISTANCE.

The borehole resistance is dramatically reduced when the flow becomes turbulent. With the TurboCollector, the transition to turbulent flow starts at significantly lower flow rates.

EXAMPLE: UP TO 11% COP IMPROVEMENT

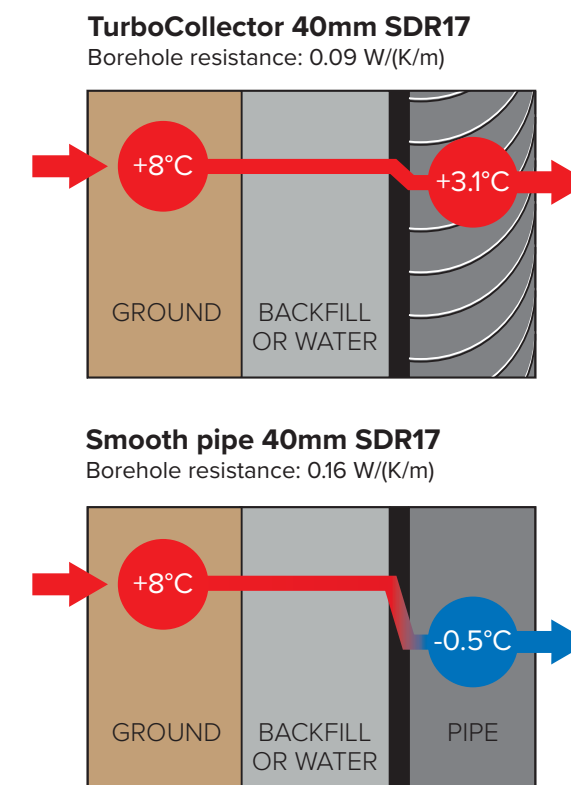
HIGHER FLUID TEMPERATURE, LOWER RESISTANCE – TURBOCOLLECTOR BOOSTS EFFICIENCY

Even if the delivered energy to the heat pump is the same, the TurboCollector will do so with a lower borehole resistance and a higher collector fluid temperature.

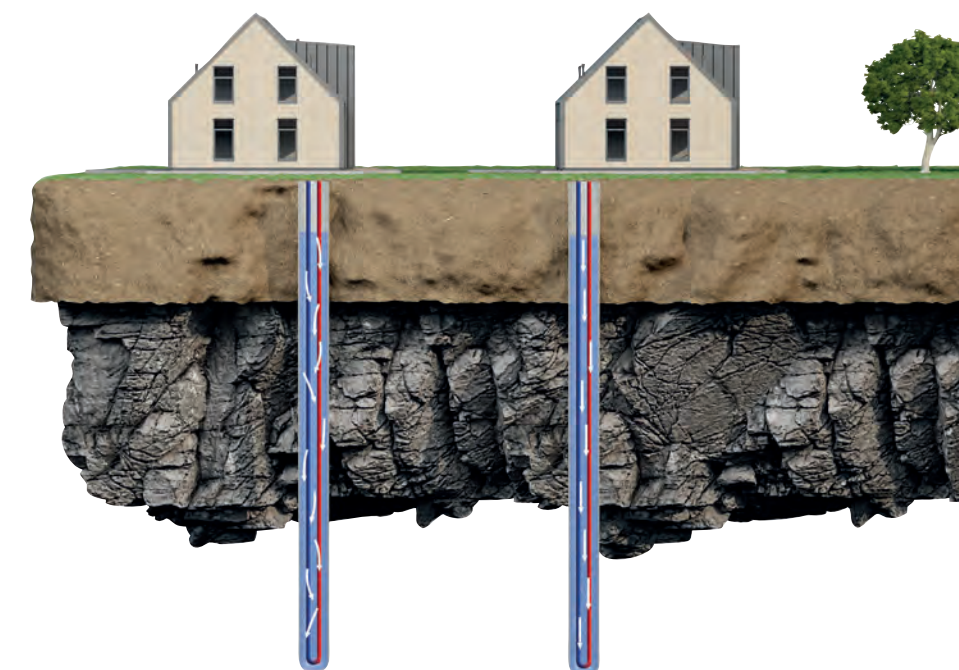
For each 1°C improvement in fluid temperature, the COP of a typical geothermal heat pump improves with about 3%.

In the example below, there is a temperature improvement in the collector fluid of **3.6°C** when using a TurboCollector, which gives **11% COP** improvement.

Example based on the following parameters:
Pipe dimension 40mm SDR 17
Flow rate of 0.4 l/s (Reynolds number 2000)
Heat transfer rate of 50 W/m.



TURBOCOLLECTOR vs SMOOTH PIPE



SCIENTIFIC STUDY: UP TO 600% INCREASE IN THERMAL CONVECTIVE HEAT TRANSFER

EXTERNAL SCIENTIFIC STUDY

Made by a 3rd party – fluid dynamics expertise at Chalmers University of Technology (Sweden).

DIRECT NUMERICAL SIMULATION

The methodology used DNS, which is considered to be the most accurate numerical method for fluid dynamics.

PRESSURE DROP AND CONVECTIVE HEAT TRANSFER

The simulations compared pressure drop and convective heat transfer for conventional smooth collector and the TurboCollector.

THE STUDY SHOWS

- Up to 600% increase in thermal convective heat transfer, which corresponds up to 85% resistance reduction
- Negligible pressure drop difference between the TurboCollector and a conventional collector outside the flow interval of Reynolds number 1,800 – 2,300 (no increase for most flow rates with a maximum difference of <2%)

The simulations and results cover a range of fluid characteristics (by using different Prandtl numbers) that includes fluids like monopropylene glycol, ethylene glycol and ethanol.



Link for the scientific study
www.muovitech.com/studies



The image shows the temperature field for the TurboCollector and conventional collector at flow rates of $Re = 2,050$. As can be seen, the TurboCollector creates unsteady flow, while the conventional collector stays laminar.

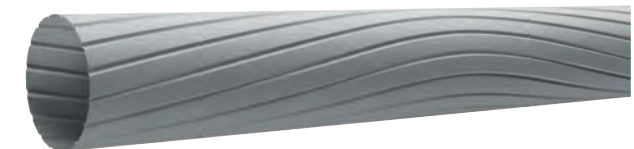
TURBOCOLLECTOR TRIGGERS EARLIER UNSTEADY FLOW – BOOSTING THERMAL EFFICIENCY

The simulations show that the TurboCollector induces an unsteady flow at about $Re \approx 1800$ while the flow in the smooth pipe becomes unsteady at around $Re \approx 2300$. This suggests that the TurboCollector has superior performance in the intermediate region $1800 < Re < 2300$ and slightly better or similar performance as the smooth pipe outside of this region.

MUOVITECH'S PATENTED FIN STRUCTURE WITH ALTERNATING DIRECTIONS PERFORMS SUPERIOR COMPARED TO ALTERNATIVE FIN DESIGNS

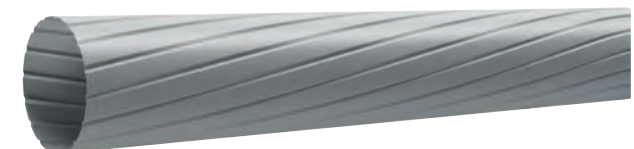
MUOVITECH TURBOCOLLECTOR (Back-and-forth fin direction)

Significantly increased heat transfer for flow rates between 1800 – 2300 Reynolds



CONTINUOUS FINS (No change in fin direction)

Insignificant heat transfer improvement



STRAIGHT FINS (Fins parallel with flow direction)

No heat transfer improvement



RESULT OF STUDY OF FIN DIRECTIONS

The study clearly shows that the back-and-forth rotation of the fins in the TurboCollector design is critical to achieve a superior heat transfer. Alternative designs with continuously rotating fins shows a negligible effect when compared with the TurboCollector. The study has also evaluated straight fins which shows no improvement in heat transfer.

