# Innovative, micro size wellbore enhancement system to boost geothermal production and thermal energy storage

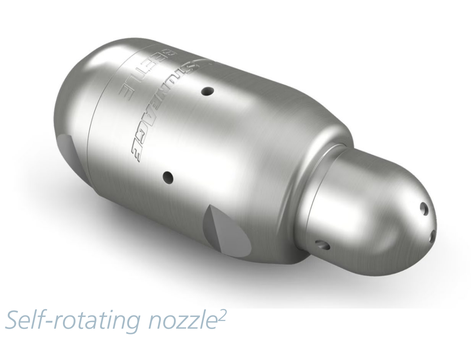
**J. Hoffmann, V. Wittig, B. Polat, Fraunhofer IEG**

Fraunhofer Research Institution for Energy Infrastructures and Geothermal Systems IEG

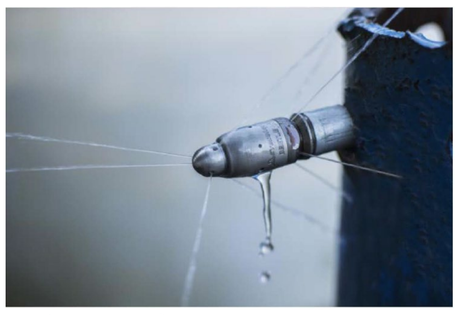
Renewables and particularly seasonable energy storage have become imperative in light of recent global developments. Geothermal heating, cooling, and it's embedded storage capabilities do present sustainable solutions that are independent of seasonable variations. However, enhancing their efficiency is both timely and essential for such systems. One crucial aspect does involve optimizing productivity, specifically refining both, interface and interaction between borehole and the surrounding reservoir. To address this, Fraunhofer IEG has been developing various micro-drilling / milling techniques for several years.

## Radial Jet Drilling as established stimulation method

Intervention methods such as hydraulic fracturing and chemical treatments, commonly utilized as EOR in the hydrocarbon industry, are often associated with environmental concerns. As an alternative, Radial Jet Drilling (RJD) presents a promising approach for establishing additional artificial flow paths and surface areas within reservoirs. Lateral boreholes of typically less than 1.5 inches in diameter, extend radially from a main borehole at deflection angles of up to 90°. This technique has demonstrated its efficacy in enhancing permeability and, consequently, overall productivity within geothermal reservoirs, all while being a relatively cost-effective, non-steerable process.[1]

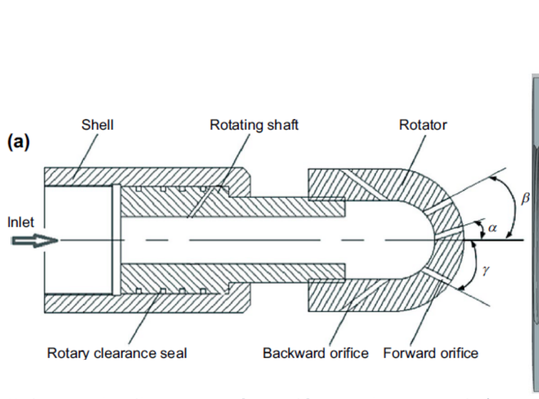


*Self-rotating nozzle[2]*

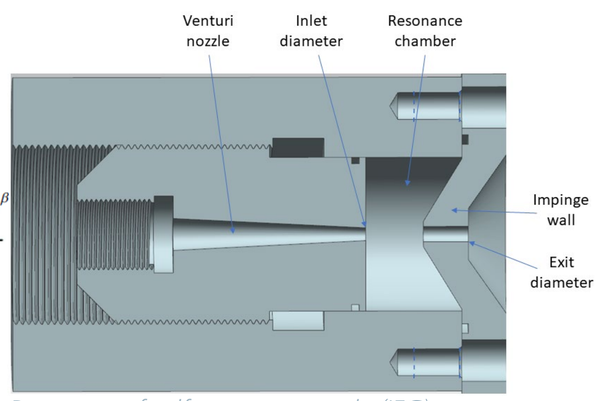


*Jetting nozzle[3]*

Extensive research and development on various nozzle types have been conducted at Fraunhofer IEG. This includes the investigation of standard static nozzles, as well as self-propelling and rotating nozzles. Additionally, self-resonant nozzles have been explored, which induce pulsation and cavitation of the escaping fluid due to the presence of a resonance chamber.




*Schematic diagram of a self-rotating nozzle[4]*

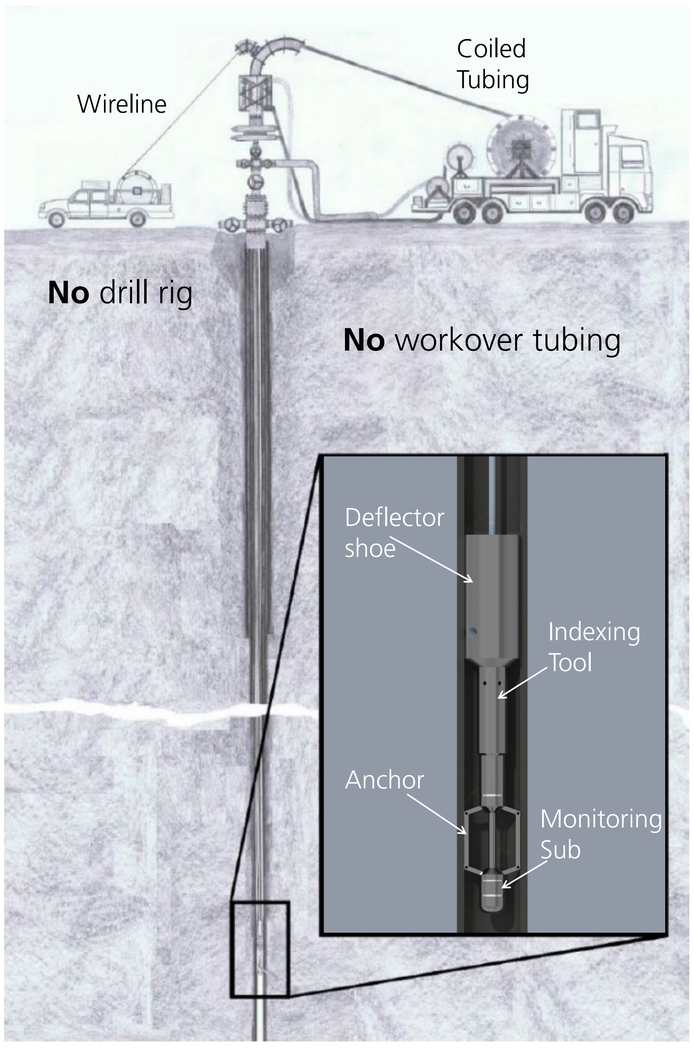



*Prototype of self-resonant nozzle (IEG)*

The established RJD method employs coiled tubing, however, it necessitates the labor-intensive introduction of a deflection system into the borehole through a workover casing and a complete drilling rig. This process contributes to significant operating times and costs. By minimizing these setup durations, operational efficiency and service delivery can be enhanced, resulting in improved safety, increased efficiency, and substantial cost savings.[5]

## Novel wireline / coil-based system for RJD

In the future, a completely new bottom hole assembly (BHA) will be deployed to the desired drilling depth using wireline technology, where it will be anchored securely. The azimuth alignment of the drilling tool is achieved through a mechanically controlled indexing tool. The tool facilitates a directional change at a consistent angle, enabling a uniform radial distribution of the micro boreholes. This innovative approach enables the drilling of an entire horizon in a single trip, facilitated by surface control mechanisms. Additionally, Fraunhofer IEG is developing a device designed to monitor and control the entire drilling process in real-time from above ground, thereby enhancing operational oversight and efficiency.




*Visualization of new coil / wireline-based BHA*

## Summary

The core of the new developments related to RJD, in addition to the basic borehole tools, is an innovative BHA system that can be used solely with a coiled tubing and wireline system, eliminating the need for a complete drilling rig. Furthermore, enhanced logging is possible by integrating a wireline for rapid data access and transfer. These additional improvements will help optimize geothermal production systems.

## Contact

Julian Hoffmann, M. Sc.
Innovative Drilling Technologies

julian.hoffmann@ieg.fraunhofer.de
Fraunhofer IEG
Am Hochschulcampus 1
44801 Bochum
www.ieg.fraunhofer.de

1 Veenhuizen, S.D., Jack J. Kolle, C.C. Rice, and T.A. O'Hanlon. 1997. „Ultra-High Pressure Jet Assist of Mechanical Drilling."
2 Stoneage. Accessed April 16, 2024. https://stoneagetools.com/
3 Saikia, P.P., U.A. Dutta, R. Tumung, S. Verma, A.U. Ahmed and A. Mukerjee. 2019. "Application of Radial Jet Drilling Technique with Gyro System to Enhance Reservoir Potential in Mature Sand Stone Reservoir in Assam-Arakan Basin Candidate Selection to Execution: A Detailed Case Study." in *SPE Oil and Gas India Conference and Exhibition*.
4 Liao, H.L., X. Jia, J.L. Niu, Y.C. Shi, H.C. Gu, and J.F. Xu. 2019. „Flow structure and rock-breaking feature of the self-rotating nozzle for radial jet drilling."
5 Dickinson, W., H. Dykstra, R. Nordlund and W. Dickinson. 1993. „Coiled-Tubing Radials Placed by Water-Jet Drilling: Field Results, Theory, and Practice." in *SPE Annual Technical Conference and Exhibition*.

Gefördert durch:
Bundesministerium für Wirtschaft und Klimaschutz
aufgrund eines Beschlusses des Deutschen Bundestages
Projektträger Jülich Forschungszentrum Jülich