High energy demand

but limited space: successful use of ground heat with JANSEN hipress

JANSEN
Plastic Solutions

«A powerful solution»: Ground heat at greater depths

The current climate debate has given extra impetus to the use of ground heat because it makes particularly sustainable heating and cooling possible for large and small energy consumers. The concept is simple – the deeper the borehole, the higher the temperature. However, the forces acting on the probe also increase with depth. With its «hipress» borehole heat exchanger, Jansen AG has developed an innovative system solution capable of operating at up to 500 metres below ground. The probe, which was launched on the market in 2018, has already become a firm fixture in the industry and proven successful in various projects. These include, for example, an apartment building that called for a heat pump solution with borehole heat exchangers requiring the minimum area for installation and offering operating cost savings.

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At a depth of 300 metre the soil has a temperature of around 20° C; at 400 metre, 24° C, and so on. The higher temperatures at greater depths represent a larger reservoir of energy and improve the efficiency of the heat pump. This type of solution can cover a building's energy requirements, even in areas with limited available space – such as in towns and cities. At the same time, however, the physical demands made on materials and machines also increase in these situations. The material has to withstand higher pressures. The standard plastic normally used for borehole heat exchangers needs to be much thicker: it must withstand the extreme pressure at 500 metre below the surface. The consequences include poorer heat transition, greater pressure loss and higher costs.

Drilling geothermal boreholes, also at increasingly greater depths, is an established practice in Switzerland. Until fairly recently, borehole heat exchangers were usually installed at depths of up to about 300 metre. Jansen and its Swiss industrial partner, the Institute for Material Technology (IWK) at the University of Rapperswil (HSR), have been working for almost five years on a hybrid probe with a much more robust plastic pipe system capable of functioning at depths of 500 metre. The objective was to design a borehole heat exchanger that would be as easy as possible to install and more energy efficient, robust and lighter than previous solutions.

New type of pipe system

The pipe system has a hybrid construction. The hybrid components have properties that single-material alternatives cannot provide. The outer and inner layers are made of PE 100 RC, the same thermoplastic material used in ordinary borehole heat exchangers. The intermediate metal layer is absolutely diffusion-resistant and lends the probe a strength and efficiency previously thought impossible. The new system has also impressed the industry. The product resulting from the research project won the European Geothermal Innovation Award at the beginning of 2019, soon followed in the spring by the German Innovation Award. The jury cited these grounds for its decision: «The JANSEN hipress has the lowest hydraulic resistance and is currently the most powerful geothermal probe on the market. And that's also without having to increase the installation diameter, which has a positive effect on borehole costs. A powerful solution.»

This reference project confirmed the system's ease of installation and operating cost savings

Deeper borehole heat exchangers are necessary where a high energy demand has to be covered and there is relatively little available space. This is the situation, for example, when refurbishing the heating systems of large residential developments. A case in point was the reference project «Chemin des Grottes» in Fribourg, the capital of the canton of the same name in western Switzerland.

A heat pump solution using borehole heat exchangers was required for an ageing apartment building with an attached low-rise multi-storey residential block. The only area accessible by normal plant and machinery stood between the apartment building and an access road, but it was not much bigger than the length of two drilling machines. Various options were investigated, and a number of different ground loop technologies compared. The final choice fell upon the JANSEN hipress, the variant with the special 42 x 3.5 mm heat exchanger pipes, due to its ease of installation and excellent reliability. The design was based on three 300 metre probes. On the tightest of sites, contractor Broder AG drilled the three heat exchanger boreholes with a diameter of just less than 130 mm to the specified 300 metre depth. The borehole heat exchangers were lowered to the bottom of the holes using hydraulically braked reels.

In detail: the patented borehole heat exchanger with its multi-layer PE-metal-PE construction was delivered to site in rolls ready for installation. Hipress is suitable for all standard drilling techniques and can be lowered using conventional methods. This was also the case in Fribourg. First, a 152 mm diameter casing was driven down to a depth of 32 metre. Then the borehole was drilled to the final depth, using a very compact down-the-hole (DTH) hammer. Probe weights were supplied to install the borehole heat exchangers. The special, metal-reinforced foot of the deep borehole heat exchanger can be split, and it was therefore mounted on the weights in an offset position with a Jansen adapter to keep the borehole installation diameter to a minimum. This means the probe can be installed extremely efficiently and with less risk of damage. Broder AG's professional drilling team used a hydraulically braked reel to install the probes in a controlled and safe manner, which was as easy as installing conventional double-U borehole heat exchangers. Broder selected the JANSEN hipress variant with factory-welded 40 mm smooth pipe connection pieces to allow the probe pipes to be connected horizontally using standard 40 mm electrofusion fittings. As an alternative JANSEN supplied 42 mm diameter electrofusion fittings for connecting the probes to the hybrid pipes.

Over the past three winters, the three installed borehole heat exchangers have reliably supplied heat for the whole residential development. Their extremely low hydraulic resistance (approx. 260 mbar at 2.2 m³/h water) and the excellent thermal transit of the probe pipes result in a considerably higher overall efficiency for the heat pump system compared with one based on conventional probe types – which has a very positive effect on the annual operating cost figures. The absolute diffusion resistance against the gases commonly encountered below ground was not strictly necessary on this site, but it is still an advantage for a system that will operate without problems over several generations. These 300 m deep probes were part of the first project to be built using the new high-pressure borehole heat exchangers.

Since the official market launch at the end of 2018, the range of accessories for this special product has been supplemented by installation tools such as an offset jet-bore tip to make hole boring very quick and easy. By the end of 2019, about 250 probes will have been installed on several large and small projects at depths ranging between 225 and 400 metre. Designers and drillers alike are impressed by the advantages of the innovative product.

In situations where heat pump solutions had earlier been thought impossible or uneconomic to install, the multilayer probe presents a favourable alternative to fossil-fuel heating systems and will provide an environmentally friendly source of energy for several generations. The most useful areas of application for the new high-pressure and diffusion-resistant patented probes include projects in densely developed districts, buildings with a high energy demand or in soils with potential for gas formation.

Reference report
Apartment building in Fribourg with JANSEN hipress I 11.2019

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