A crystal clear solution

Mike Deed, of Geoquip Water Solutions, reports on the treatment of geothermal plant with Boresaver at a retail/industrial complex in Milan, Italy

IRON oxide residues in groundwater are becoming an increasing problem, estimated to affect about 40% of the world's water bores, and anecdotal evidence indicates that this figure is steadily increasing. Whether caused by naturally occurring bacteria or straight chemical means, these residues will eventually affect nearly everyone sourcing water from groundwater aquifers.

These residues result in an oxide and biofilm that builds up in pumps and headworks, and this is particularly significant for a geothermal-heating plant. Any blockage or restriction within the pipework and distribution system will severely reduce the flow section of the system and increase the friction losses, causing inefficiency, wasted energy, increased operating costs and compromising the original reason for opting for geothermal energy.

This case study considers an air-conditioning system servicing a 150,000m^2 retail/industrial complex in Milan, consisting of numerous offices, multiple car showrooms, mechanical workshops, training facilities and warehouses. The system, producing 6MW (co-efficient of performance=4), comprises nine geothermal plants (with the largest system 50,000 litre capacity), three wells (each approximately 40m deep) and 10km of pipework of between 10m and 250mm diameter.

Groundwater is pumped for four months in the summer (mid-May to mid-September) and for six months in winter (mid-October to mid-April). There is a one-month interruption between these two periods when, conveniently, maintenance can be carried out.

Within the secondary closed circuit – which carries the conditioned waters coming from the heat-exchange plant to the various buildings – there had been cases of blockages due to biofilm containing iron hydroxide. Tests and analysis carried out showed an increase of iron and iron-related bacteria (IRB) levels both in the groundwater (at the beginning of the water circuit) and water flowing in the secondary circuit (at the end of the water circuit).

Iron bacteria can be dangerous for two reasons. Firstly, it can damage metallic pipes by corroding the non-plated parts of the pipes, increasing any electro-chemical corrosion that may already be present. Secondly, it causes biofilm (biofouling), which can build up within the pipes, reducing the flow rate.

This particular system was severely contaminated with IRB, including the extraction wells, primary and secondary-heating loops, and even the convector heating systems in the offices where the pipes are as small as 10mm. Typical symptoms included poor flow, orange/brown residue inside the pipes and filters, and high working pressures in the secondary system. The system was clogged and in some cases completely blocked by the biofilm and oxide residue produced as a direct consequence of the IRB.

The consultant decided to use Boresaver to solve the problem because of its ability to dissolve the oxide residues as well as to combat the IRB contamination. The product could be used without dismantling the equipment and would not attack or deteriorate any of the materials inside the system.

System storage tank

Boresaver dissolves and/or loosens oxide deposits by processes of reduction and complex formation in mildly acidic conditions. In the process, components of Boresaver are converted to carbon dioxide and water. Boresaver is readily and rapidly biodegraded under aerobic and anaerobic conditions after it has done its work and has been diluted in the flushing process. One of Boresaver's key components is ethanedioic acid (oxalic acid); a substance that occurs naturally in plants and vegetables, making the product biodegradable and environmentally friendly.

Boresaver is approved by the Drinking Water Inspectorate (DWI), part of DEFRA, for use in potable water applications – useful if water from the wells is used for both geothermal applications and a potable water supply.

The first part of the system to be treated was the extraction well. Then the treated water was used to fill the whole system, including the secondary loop that had compromised every part of the system. The pumps and system remained intact whilst the treatment was carried out. This reduced plant downtime and minimised the cost of rehabilitation. Following treatment of the wells, the pumps were used to manage the movement of further Boresaver Ultra C treatment throughout the rest of the distribution pipework, evaporators and condensers of the heat exchanger. The complete treatment of each well and distribution system was completed within four days.

The secondary systems were cleaned using the Boresaver Ultra C by pre-dissolving the chemical in industrial bulk containers and then pumping this solution using small, circulating pumps around the various systems. Once inside, the main circulating pumps were used to re-circulate the treatment water for a period of 24-48hrs, following which the system was purged with fresh water from the wells and then finally refilled.

Once the systems were cleaned, it was essential to control the iron-related bacteria so that future

Monitoring during purging as the iron in solution (green) passes to clear water

treatments could be carried out on the basis of a maintenance dose rather than at the full dose. Since the bacteria populate exponentially, it is better to maintain a suitable, proactive maintenance regime than to react when the system becomes a catastrophic failure. Over time this has proved to be more cost-effective. This regime also included the use of the Boresaver Liquid maintenance product, which was dosed into the closed, secondary loops as well as into the wells – the ultimate source of the original contamination.

Since the treatments can be carried out without removing the pumping plant and dismantling the system, great savings can be enjoyed whilst still enabling the system to be successfully cleaned. In all cases, good monitoring is essential to manage the most effective time for ongoing treatments. Regular, proactive maintenance always proves to be most cost-effective in the long run.

The result of this treatment was that the iron mass was removed from the circuit itself and that other material trapped within the residues (sand, slime, clay, etc) were released. All of the above material – easily removed after the treatment – would otherwise have blocked the pipes, preventing the plant from working properly.

The same treatment was repeated in the other two wells and in the related water circuits. It was suggested to repeat the treatment every two years for maintenance and prevention.

The M&E contractor later reported a doubling of performance on the three worst-affected plants with an increased performance across all plants.

Well extraction point during recycling