Case study

Nickel Removal from Potable Water

Not everything that is of natural origin can be claimed as being good for human health. This counter-intuitive situation was experienced several years ago by the 1200 villagers of Fuchshain, which is in a small municipality close to Leipzig in the eastern part of Germany.

Unlike many situations of drinking water contamination, the nickel that was found in the water of the Fuchshain-well was not originating from any ruthless factory or caused by any illegal waste disposal. It was simply leaching out of minerals that are found in this area by natural geological reasons. To be more precise, it is present in pyrite, which is a well known iron based mineral, and commonly to be found in the earth crust.

Nickel is under suspicion to cause cancer, and to have sensitising effects on the body of a human being that drinks nickel containing water for a long period of his life. Therefore, the German ministry of health and environment regulates the maximum content of nickel in potable water.

In 2003, the maximum contaminant level was limited to 20micro-grams per litre (ppb) thereby replacing the older German limit of 50ppb. Since the raw Fuchshain-well-water contains nickel in a concentration of 35micrograms the water supplier was under pressure to take action to get the well water back in compliance with the national regulations. But, none of the villagers in the beginning had a clue how to tackle this task.

Actually, the problem of nickel-contamination in groundwater was not a local problem of the villagers of Fuchshain alone. Since the mineral pyrite can also be found elsewhere, it is a problem that occurs also at other locations, and therefore, had already drawn attention of the scientific community of Germany as well as of the governing authorities. Years ago a state owned institute, the IWW in Muelheim an der Ruhr, had already started to study the phenomena and even more important, they had tried to find technical solutions. In a long term study, several technical options had been tested out, finally indicating that the most efficient method for the treatment is the application of a nickel selective adsorber material which is belonging to the group of the so called “chelating ion exchangers”.

Ion exchangers in general consist of fine polymer beads which are of the size of half a millimetre only. As like sand this material can

The problem of nickel-contamination in groundwater is not a local problem anymore.

By Dr. Stefan Neumann

be filled into tanks whereby water is purified while it is percolating through the material. The polymer beads are equipped with fine pores to allow water to channel inside the beads. The inner surface the beads is coated with chemically active groups that can react with water constituents. The so called "chelating ion exchangers" possess particular chemical properties that render them suitable to selectively pick out the nickel in the water, and leave other valuable minerals untouched.

Since the IWW-institute had already gathered vast experience and data on this application in years of piloting work, they were involved in the Fuchshain-issue and asked for their consultancy. A few months later it was decided to build the first technical scale ion exchanger plant for the removal of nickel from potable water in Germany. The technical solution realised at the Fuchshain-well consists of two filter columns each containing 0.7 cbm of Lewatit TP207 - a chelating ion exchange resin manufactured by LANXESS, one of the leading manufacturers of premium ion exchange resins. The columns are plumbed in a way that they can be operated in both series or parallel sequence. The average flow is 35cbm/h. The anticipated operating time until the exhaustion of the filter is more than one year with an operating capacity of between 10-20gms of nickel adsorbed per litre of filtering material.

The plant was successfully operated more than a year under strict control of the quality of the outlet water. That pioneering work was carried out with high attention from different parties: water works employees, specialists of the IWW-institute, but also from the federal and national authorities.

Finally, the performance of Lewatit TP 207 was fully validated for nickel removal. Not only that the nickel had been efficiently removed from the well water with concentrations safely below the limit. It was also found that the selective adsorber did not change the over all quality of the water, not by changing the natural mineral composition of the water, nor by violation of any other hygienic standard – such as bacterial count, etc. After this positive test results the German ministry of environment and health listed the TP 207- type of chelating ion exchange resin in its positive list for medias and chemicals permitted to be used in water treatment (Liste der Aufbereitungsstoffe und Desinfektionsverfahren gemäß § 11 der Trinkwasserverordnung).

Economic considerations indicated specific operating costs in a range of a few Euro-cents per cubic-metre of water, including depreciation of investment costs. The nickel removal filters of the Fuchshain-well have been successfully operated since August 2004 and have been regenerated several times. The regeneration process has been proven to provide no negative impact on the resin performance either.

The Fuchshain experience was encouraging other customers to also invest in chelating ion exchange resins to solve their nickel problem. In the meantime more than 7 reference plants have now been installed in Europe and all operate with satisfying results. It turned out that this treatment method is of special interest for smaller communities that are located at remote places in country sides or mountain areas. Finally, it has to be stated that selective ion exchangers can be used to also remove other contaminants than just nickel. Solutions for the removal of lead, cobalt, copper, chromium, manganese, uranium, arsenic, radium etc are available. LANXESS technical specialists are eager to help customers to find the right ion exchange product to tackle individual purification issues.

About the Author

Dr Stefan Neumann is working as Technical Manager on Ion Exchange Applications at LANXESS Deutschland GmbH since 2005. He has studied chemistry at the University of Cologne, Germany. He has earlier worked for University of Leipzig (HTWK), Germany, and Bayer Technology Services. He is currently head of Ion-Exchange - application laboratory for planning, coordination and evaluation of tests related to above mentioned working fields. He also works on marketing strategies to promote ion exchange products, technologies and applications.

We look forward to your feedback on this case study. For further information on the author, you can write to us at content@eawater.com