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GUEST COLUMN

Worldwide potential of riverbank filtration

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As the demand for piped drinking water is increasing in developing economies, water utilities are facing the challenge of treating surface water that is often polluted. Furthermore, many cities in developing countries are examining the feasibility of providing a continuous pressurized supply on a 24 h basis to reduce cross contamination. This practice is adding further stresses to treatment capacities in many cities. Riverbank filtration (RBF) is considered to be an excellent treatment (or pretreatment) technology for drinking water production. When wells are placed sufficiently close to a river and pumped, a part of the pumpage is induced infiltration water from the river. In the case of a lake, the process is called lake-bank filtration. As the induced surface water filters through the riverbed sediments and aquifer materials, most suspended and dissolved contaminants, including pathogenic bacteria and viruses are filtered out.

RBF has been used in Europe for more than a century to supply drinking water to communities along the Rhine, Elbe, Danube, and Seine rivers. RBF systems have also been supplying drinking water to several communities in the US for nearly half a century. In post-World War II Europe, when the rivers were significantly polluted with municipal and industrial effluents, RBF was the most efficient method of producing high quality drinking water. Pollution in the Rhine in 1960s and 1970s was so severe that the river was termed the "Sewer of Europe" in the Netherlands. At that time, RBF and filtration of river water through dune sand provided drinking water to many communities in the Netherlands. Many of these systems are still functioning well. As late as 1980s, rivers such as the Elbe that passed through the former Czechoslovakia, East Germany, and West Germany contained significant amounts of industrial waste, particularly from the pulp and paper industry. Water quality was poor. RBF systems on the Elbe around the City of Dresden were able to remove most of the surface water contaminants. Recent studies show that RBF is capable of removing many pharmaceutical compounds, pesticides, and endocrine disrupting chemicals that are present in surface water. Removal of natural organic carbon also reduces the formation of disinfection byproducts during chlorination.

Some of the most densely populated countries are located in Asia. Drinking water supplies in large cities in those countries mostly come from surface sources. For example, in India and China, a large number of cities are located along rivers, and provide potable water to hundreds of millions of people. In the Ganges Plains, many rivers are perennial, fed by snow and ice-melt waters from the Himalayan mountains. The major rivers of China also receive snow-melt runoff. The perennial nature of these rivers attracted the development of cities along their banks. Many of these cities are large with millions of people living in them. Subsequently, irrigation systems were developed to produce crops during the summer months. Reduction of flow due to irrigation diversion, and discharge of municipal and industrial effluent (often receiving only primary treatment) have caused tremendous water quality degradation in these rivers. For example, the City of Kanpur, India, located on the bank of the Ganges, has a metropolitan population of about 5 million. Before the construction of a new barrage and treatment plant, a diversion canal brought water to the treatment plant. The main industries in Kanpur are textiles and leather tanning. Often blood-red dyes can be seen in the river from the railway bridges. The treatment

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plant's capacity was not sufficient to provide 50 l/day per person. The source water was of such poor quality that prechlorination was needed to remove color and organics. There was no monitoring of trihalomethanes formed during the process. Fortunately, the city has built a new treatment plant near the Ganga barrage where the water quality is better than at the downstream locations (Fig. 1). Cities such as Delhi, Mathura, Agra, Lucknow, Allahabad, and Varanasi face similar challenges for water supply. All these cities in the Ganges plains cannot build large storage dams due to the flat topography. Reliance on flow in the rivers, a significant part of which can be sewage, has stressed the treatment systems of these cities. The situation is China is also dire in certain locations because of industrial and municipal effluent discharge into rivers.

Fortunately, a number of cities in India have started using RBF for water supply. For example, the City of Hardwar in the state of Uttarakhand uses a number of collector wells to extract water from the Ganga and its diversion canals. The cities of Faridabad, located just south of Delhi in the state of Haryana, and metro Delhi are beginning to experiment with RBF. Other Indian cities such as Ahmedabad in the State of Gujarat, and Kota in Rajasthan State also have used RBF on a limited scale. The Indian Railway has been a user of RBF for several decades for providing drinking water to rail cars and stations in the Medinapore area of West Bengal.

Unlike India and China, rivers in Korea and Japan are short and have steep slopes. Often the alluvial aquifers are thin. However, efforts are being made in Korea to use RBF for water supply as well as for improving the ecological quality of stream water in the urban environment. Although the minimum level of sewage treatment is "secondary", the effluent percentage in many smaller rivers can be as high as 80%. Odor and poor water quality have forced many cities

Fig. 1 Intake points for one of the water treatment plants in the City of Kanpur, India

to consider an additional level of treatment. As a cost-effective solution, many cities are experimenting with the use of RBF to produce higher quality water from the polluted rivers, piping the water to the headwater areas and discharging there. The City of Kimhae, along the Nakdong River in Korea is installing a RBF system to extract 200,000 m^3 of water daily for drinking water supply.

Many of the large cities of the world are located along the banks of large rivers. For example, Cairo in Egypt relies on the Nile for water supply. In the vicinity of Cairo, the Nile receives tremendous amounts of pollution from municipal and industrial effluents and agricultural drains. With the rising population in and around Cairo, the pollutant load to Nile is increasing. On a limited scale, smaller cities along the Nile are showing that RBF can be an effective and economical means of drinking water production.

The worldwide potential of RBF is significant. As per a preliminary survey by Jones, Jordan, and Goulding (a consulting firm headquartered near Atlanta, Georgia, USA), RBF can potentially supply water to 120 million people in the US alone. Similarly, most cities on the Ganges Plain and large riparian cities in the southern and eastern part of India could benefit from RBF. Many large cities along the major rivers of China can easily use RBF for their water supply. Informally, we have received inquiries from colleagues in China about the feasibility of RBF for improving the ecological health of river tributaries and lakes that receive heavy sewage loads. In other regions of the world such as Africa, northern Asia, and South America, potential exists to use RBF for water supply. A petrochemical plant explosion on 13 November, 2005 in the City of Jilin in China sent a toxic spill of more than 100 tons of benzene and nitrobenzene into the Songhua River, a tributary of the Amur River in Russia. Currently, there are discussions in Russia about possible installation of RBF systems for cities like Khabarovsk (population 600,000) along the Amur to deal with such pollution problems in the future. Cities along the Niger River in Nigeria (e.g., Onitsha, with a population of more than 500,000) and cities in other West African counties (Niamey, capital of Niger with a population about 1 million) could use RBF. In South America, many large cities are also located on riverbanks. The City of Ciudad Bolivar (population around 350,000) is located on the Orinoco River in Venezuela. A number of cities are also located along the Parana/Paraguay River (e.g., Asuncion, Paraguay, population 6.5 million; Parana, Argentina, population, 275,000; Rosario, Argentina, population 1 million). Although these cities appear to be located on alluvial deposits along these major rivers, site-specific hydrogeologic data along with economic and engineering analysis will be needed for the implementation of RBF systems at these locations.

In short, RBF has the potential to supply water to numerous cities around the world. Many of these cities are currently using surface water that is often of poor quality. Gradual conversion of surface water intakes to bank filtration can help improve the water quality.

Author Biography

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