Future water systems

Introduction

The long experiment of supplying drinking water through water mains and taps in individual houses and apartments worked fairly well for some time in sparsely populated temperate climates where there was abundance of clean fresh water. It has, however, never been a really good option in tropical, densely populated areas with limited water resources.

Now also in more water fortunate areas, raw water is deteriorating and water mains are breaking down.

It is more and more difficult to supply high-quality drinking water and, in any case, less and less people are willing to risk their health by drinking disinfected all-purpose water, because disinfection by its very nature creates by-products (DBPs) that are known to have negative long term effects on health.

In most countries, the ones who can afford it buy dedicated drinking water in bottles or other containers. Some even produce their own drinking water by treating the tap water with various devices.

Just as industry increasingly demands different qualities of water for different purposes, so will communities. **Drinking and eating will be one specification, bathing and showering another, washing another and agriculture another**. In planning water supply one has to take these developments into consideration.

Present trends in water supply in the EU and the US

Deteriorating tap water systems

A report in February 2002 from Harvard School of Public Health shows that the renovation of US municipal water systems needed to prevent waste water to get into the drinking water would cost 141 billion US dollars. An expensive proposition which, by the may, is not enough in itself to secure that the water can be universally trusted for drinking. The situation is similar in all countries where large municipal underground water purification systems have been built.

In spite of modern equipment, labour cost has risen considerably for digging underground. Therefore, municipal authorities are reluctant to renovate mains unless there is a significant leak. They do not even bother to repair smaller leaks and typically 20 – 80 percent of the water is lost in transport from the purification plants.

Although all cities are making minor improvements in the distribution system from time to time, there is no room in any city's budget to revamp the entire water piping system. Normally with the present patching of pipes it would take centuries to renovate the whole system. And even if one were to speed up the work to renovate the system, residual disinfectants will always be needed to protect the water from biological contamination.

Also sewage pipes leak, and are even less repaired and thus the ground in most cities is seeped with sewage and there is a terrible stench each time there is an excavation. The sewage may find its way into the fresh water pipes. This is one of several reasons why disinfection is needed.

Science discovers new contaminants and their effects

There is a strong resistance among water works against new regulations. One reason is that some contaminants, like disinfection by-products, simply cannot be avoided, while others, like arsenic and some microbes like Cryptosporidium, Helicobacter Pylori and Naegleria are almost impossible to get rid of.

Recently it has been calculated that adding arsenic removal to a municipal plant may increase the water cost to consumers by several hundred percent. This I why there has been such a strong debate over the new arsenic regulations in the US. What happens, the utilities think, when another similar regulation is to be followed – another 100 percent increase or more?

However, the consumers led by consumer advocate groups will naturally demand more and more safety in the tap water as science constantly increases our knowledge of the effects of contaminants – not only acute effects such as death and diarrhoea, but also the long term effects such as stomach ulcers, cancers, neurological disorders and probably also illnesses such as Alzheimer's and Parkinson's.

The situation will be untenable for the water utilities. Therefore water treatment professionals make a great effort in marketing Point-of-Entry systems. However, the Point-of-Entry systems that remove all potential contaminants are today so complicated and require such expert maintenance that their use is prohibitive if failure is not an option. What remains is bottled water and fail safe point of use equipment.

Dedicated drinking water

Consequently, more and more people are buying bottled water or buying their own point-of-use water purifiers. Although it is a probable development that each house or each apartment will have its own designated drinking water purifier, this development will take decades. On an international scale, the bottled water market, which is presently growing with 20% each year, will therefore continue to increase in this extremely rapid pace in the foreseeable future.

Traditional bottled water has developed from the luxury product mineral/spring water and is very expensive. In Europe, known brands may cost 1 000 times more than tap water, i.e. around the equivalent of 1 € per liter and the cheapest brands will cost at least 200 times more than tap water, i.e. the equivalent of 0.2 € per liter.

In considering new water systems one should start investigating the possibility of manufacturing and distributing highest class drinking water in a rational way. The manufacturing cost of the water will not be more than the equivalent of 0.002 € per liter. Consumer cost will depend on which distribution system is chosen.

According to a recent study by Stanford University, the normal water intake of surveyed citizens in a tropical climate (Bangladesh) is 3 liters per day but shows variations up to 6 liter per day. Both figures are surprisingly low. We believe for planning purposes 5 - 15 liters per day and person for drinking and cooking would be a good target as regards dedicated drinking water. For this limited amount of water the absolutely best water purification technologies are feasible and rational.

Water for drinking and cooking should then be distributed in containers like any liquid food and not in pipes. An alternative is of course Point-of-Use purification in the kitchen.

Reuse of hygiene water.

During at least half a century there has been a development for reducing the environmental impact of industrial effluents. In recent years, efforts are also made to reduce the volume of effluent by reuse of water. Another step ahead and Zero Liquid Discharge (ZLD) will become the norm.

Even though a ZLD system can be designed to make even purer water than what is commonly delivered on tap, there is a resistance to use it for drinking water. Just the thought of drinking something that has been manufactured from one's own sewage is distasteful for most people. However, combined with a dedicated drinking water system, a ZLD will be perfect for manufacturing of all-purpose water.

According to the UN, total per capita need of all-purpose water in a household is 100 liter per day. In Sweden the average use is 380 liter per day. In the US it is higher. A good target might be 400 liters per day per capita.

Co-generation

To meet these demands Scarab Development has developed a co-generation system based on low temperature distillation by membrane distillation technology. The equipment can be used both to manufacture dedicated drinking water and re-circulate all purpose water. The system runs on waste heat from power plants.

The world average annual per capita energy consumption is approximately 65 GigaJoul which equals 18 000 kWh or 50 kWh per day. Most of this energy is produced in thermal processes and creates at least a similar amount of waste heat. In a low temperature distillation process, this waste can be used for purification of water. Assuming that only half of all energy processes are thermal and that only half of the waste heat these processes produce is used, the waste heat produced per capita will be enough to manufacture an international average of several hundred liters of absolutely pure water per capita per day.

Availability of waste heat will of course vary from location to location, but, in many areas of the world, this type of co-generation is the best option for a good future water supply. Technology for such purpose has been developed during the last 10 years by Scarab Development AB in co-operation with the Royal Institute of Technology in Stockholm, Sweden, and a first test of commercial grade equipment has started in 2006 at a power plant in Sweden.

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