WATER SUPPLY AND SANITATION TECHNOLOGY

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Summary

The first target of water supply and sanitation technology is to reduce the potential of infectious diseases. Protecting clean water sources from microbial contamination is of prime importance in assuring the provision of safe water. However, pathogen-free clean water is rarely available and some kind of treatment is needed before consumption.

Rainwater harvesting is one of the most important techniques which human beings have used for millennia. Rainwater harvesting is still very beneficial for those who live in

remote areas without a piped water distribution network. Groundwater is normally reliable and basically a safe water source for domestic use. Traditional wells include a raised wellhead to prevent wastewater from running back down the well. Surface water is clean at source (i.e. rainfall) but is easily contaminated as it flows over the ground, so protection from contamination is of major concern.

Raw water purification systems should be selected from one of the following schemes: disinfection, slow sand-filtration disinfection, and rapid sand-filtration disinfection. Auxiliary treatment processes such as neutralization and pre-chlorination are added to the above systems as required.
Not all the water supplied into a distribution network actually reaches individual use points. Instead, a substantial amount of water leaks during distribution. Water leakage causes several adverse effects for operating and managing water supply systems, and efforts must be made to minimize the leakage. The most common method for detecting leakage points is leak sounding. Maintenance staff listen to the sound of water leakage.

Environmental sanitation systems should be fully utilized by the whole community. Therefore the appropriate technology should be provided for the whole community.

Development of water supply and sanitation infrastructure requires huge investment and a long time. Improvement plans should, therefore, be accompanied by the current picture as well as the “should-be” picture. There is a valuable scheme known as “some for all rather than more for a few”, which is a means of providing water equally to as many people as possible. The same concept applies to the sanitation field.

1. Introduction

The appropriate technology of water supply and sanitation is affected by the geological, economic and cultural characteristics of the projected area. The first target of water supply and sanitation technology is to reduce the potential for infectious diseases. Protecting clean water sources from microbial contamination is of prime importance in assuring the provision of safe water. Pathogen-free, clean water source is rarely available, however, and some kind of treatment is usually needed before consumption.

Most pathogens in water are associated with suspended particles, so the train of treatment units should involve a solid-liquid separation process, followed by removal of impurities and then disinfection processes.

The sanitation system should be developed in tandem with the water supply system because most of the pathogens in the living environment are related to excreta. The selection of a sanitation system for on-site or off-site treatment is heavily dependent on the economic potential of the projected area.

2. Water supply technologies

2.1. Water source management

Rainwater is one of the most attractive water sources in regions where plentiful precipitation can maintain an assured small-scale water supply. It is necessary, however, to educate community residents to maintain clean and hygienic conditions in the rainwater harvesting area, rainwater collection facility, and storage tanks.

It is clear that water quality deteriorates as a result of toxic substances that affect springs, groundwater, infiltrated water, and surface water. The costs for the intake and transmission of water are of the same order as the costs involved in securing water quality. Therefore, intake and transmission considerations should be related to quantity and quality of water sources, and selection of the optimal method for providing the most stable and economical water supply system.

2.1.1 Rainwater harvesting

Rainwater harvesting is a very important technique which humans have used for millennia. Rainwater, in theory, is very clean and free from pathogenic microorganisms, since it comes from evaporated seawater. Though it absorbs or dissolves some substances during precipitation, it is still clean enough for potable use.

Rainwater harvesting is particularly beneficial for those who live in remote area without a piped water distribution network. Further, many of those who are regarded as without access to safe drinking water by the report “Global Water Supply and Sanitation Assessment 2000” live in regions where rainwater harvesting is available and affordable. Primarily, rainwater harvesting is appropriate for a semi-arid seasonal climate where relatively large storage volumes are needed. It is evident, however, that this method is also useful for many part of the world that receive more rainfall, throughout the year. Many examples have, therefore, been reported from various parts of the world.

Roof catchment systems are the simplest and most widely used application, requiring only a roof gutter and a reservoir. People use various materials to build the facility, depending on what is available locally. The size of the reservoir depends on the climatic condition of the region. Semi-arid regions, or regions with a relatively long dry season, require large reservoirs to store a quantity adequate for long periods without rainfall. For more humid regions or regions with a constant rainfall throughout the year, the size can be decreased to provide for shorter periods of time.

Several organizations and agencies are promoting and enhancing the implementation of rainwater harvesting systems for low-income countries. Certain donor agencies, e.g. UNICEF, SIDA, etc., are prominent in their support. Even more ambitious, the Rainwater Harvesting Research Group (RHRG) has been established to link researchers and practitioners in the UK, Germany, India and Sri Lanka, and including partnerships with projects in East Africa. RHRG promotes exchange of skills, knowledge and experience between participants.

In addition to capturing potable water, rainwater harvesting is promoted to mitigate inundation in urban areas. Stored rainwater is utilized for non-potable uses such as toilet flushing or clothes washing. Local governments in Germany provide subsidies and other incentives to promote rainwater harvesting. In Japan, large buildings are equipped with underground storage for rainwater, which is eventually utilized for miscellaneous purposes, other than drinking

2.1.2 Traditional wells

Groundwater is normally reliable and basically a safe water source for domestic use. Shallow wells have been used as a source of water for millennia. Traditional wells include a raised wellhead to prevent wastewater from running back down the well. For deeper wells, bucket hoists are provided. The windlass method of raising water provides a hygienic store for rope or chain, keeping it away from ground soil.

2.1.3 Spring protection

In high rainfall regions where surface water is abundant, people often depend on surface water for their household use. Surface water is clean at source but is easily contaminated as it flows. Protection from contamination is, therefore, of major concern. Spring water and streams in deep forest and mountains are the most desirable places from which to fetch water. The sources should be either naturally or artificially protected.

There are three fundamental points to bear in mind when protecting springs. 1) Spring water usually runs continuously at a fairly constant rate, so a storage tank may need to be provided to cope with fluctuations of usage. 2) The storage should be well protected to avoid contamination by animals or humans. 3) The outlet of the spring can be improved to increase the yield of water.

2.2. Water treatment

Raw water purification systems should be selected from one of the following schemes: disinfection, slow sand-filtration and rapid sand filtration. Auxiliary treatment processes such as neutralization or pre-chlorination may be added to the above treatment systems, as necessary.

2.2.1 Outlines

Water treatment can be defined as technical operations that, by combining several treatment unit processes, fill any gaps between raw water and purified water. The water purification processes that are applied in drinking water supply are: (1) the separation of impurities from water, (2) increasing the size of the particles, and (3) inactivation of microorganisms. Solid-liquid separation by straining, screening, sedimentation, and filtration, are commonly used separation processes in conventional water purification systems. If, however, the raw water contains soluble impurities that must be removed, an interface transfer process such as adsorption, ion exchange, aeration, extraction, or electrical dialysis must be applied for purification. The efficiency of the solid-liquid separation processes is affected by the size, density, concentration, and physico-chemical reactivity of discrete particles in the raw water.

A simple solid liquid separation process cannot effectively remove all the discrete particles in natural water. Therefore, the physico-chemical properties of the particles are adjusted to improve their treatability; this may be done by coagulation and flocculation.

One of the most important water purification processes is inactivation of microorganisms by disinfection. Chlorination and ozonation are disinfection processes that reduce the potential of infectious diseases borne in drinking water.

The unit process commonly adopted in drinking-water supply is limited in its ability to remove impurities. These limits vary according to the impurities' size, chemical reactivity, concentration, and also from the point of view of economics.

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Biographical Sketch

Yasumoto Magara is Professor of Engineering at Hokkaido University, where he has been on faculty since 1997. He was admitted to Hokkaido University in 1960 and received the degree of Bachelor of Engineering in Sanitary Engineering in 1964 and Master of Engineering in 1966. After working for the same university for 4 years, he moved to the National Institute of Public Health in 1970. He has served as a Director of the Institute, since 1984 for Department of Sanitary Engineering, then Department of Water Supply Engineering. He also obtained a Ph.D. in Engineering from Hokkaido University in 1979 and was conferred an Honorary Doctoral Degree in Engineering from Chiangmai University in 1994. Since 1964, his research subjects have been in environmental engineering and have included advanced water purification for drinking water, control of hazardous chemicals in drinking water, planning and treatment of domestic waste including human excreta, management of ambient water quality, and mechanisms of biological wastewater treatment system performance. He has also been a member of governmental deliberation councils of several ministries and agencies including Ministry of Health and Welfare, Ministry of Education, Environmental Agency, and National Land Agency. Meanwhile he performs international activities with JICA (Japan International Cooperation Agency) and World Health Organization. As for academic fields, he plays a pivotal role in many associations and societies, and has been Chairman of the Japan Society for the Water Environment.

Professor Magara has written and edited books on analysis and assessment of drinking water. He has been the author or co-author of more than 100 research articles.