Water Saving Technology and Current Conditions in China

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Abstract

This paper outlines various issues concerning domestic use of water in China, and summaries water saving technology and associated research. It also introduces water saving related standards of China.

Keywords

China, water resources, domestic use, water consumption, saving water, water supply system, sanitary appliances

1. Water resources

China is a country with limited water resources and suffers from serious water pollution. It is one of the 13 countries around the world, which suffer from lack of water resources with water resource volume per capita in the country as low as one-fourth of the world average. This scarcity of water is already becoming an obstacle to the nation's sustainable development. Currently China's annual water supply 583 billion m^3 is 3.5 billion m^3 short of annual demand of 618 billion m^3. Demand for water is expected to increase rapidly in tandem with the country's fast-paced economic growth. Without forcible water-saving measures and at the current rate of rise, water demand is bound to reach 734 billion m^3 by 2010, a shortage of 91 billion m^3 against an estimated supply of 643 billion m^3. In this light, water saving can be seen as the most urgent national policy demanding our immediate attention.

2. Issues Concerning Domestic Water Use in Architecture

Domestic water use in buildings accounts for 60% of all urban water use. This figure is expected to increase further as the development of urban construction and improvement of infrastructure accelerate. Consequently, solving water saving issues related to domestic water use in buildings holds keys to promoting a water saving movement in China.

In recent years, water saving in buildings in China has achieved positive results by concerted efforts of relevant governmental departments and engineers. However, the following problems remain to be solved:

(1) The volume of water used to which a fixed rate of charge is applied (basic unit of water supply) is too large.

(2) Non-traditional water sources are not utilized efficiently.

(3) Too much pressure is exerted on the part of the system. The pressure balance between water supply and hot water supply is not properly maintained, and as a result circulatory effects of hot water supply pipes are poor.

(4) The national and industrial standards are not satisfied due to deterioration of materials, fittings, and valves. Precision is lacking in installation and maintenance; as a result leakage loss is understated.

(5) Water saving apparatuses and nozzles are not utilized.

(6) Amount of water use is not properly measured or controlled because of inappropriate installation or deterioration of water meters

3. Important Technology in Water Saving in Buildings

On top of obtaining proper governmental support and administrative control, and raising the public awareness, it is necessary to solve some technological problems to ensure smooth implementation of water saving in buildings. The following are some important issues on the subject.

3.1 Reasonable fixed rate amount

The fixed rate amount consists important basic data in designing water and hot water supply systems. Setting it too high would cause water supply facilities and pipe diameters to become too large, increasing cost in terms of water use, energy, and materials. At the same time larger space would be required to install facilities; this in turn may cause water waste on the users' part. Establishing a reasonable fixed rate amount, therefore, is essential in designing water saving technology, and also gives administrators a good rationale to limit water use.

3.2 Development of new sources and distributary supply

The amount of sewage water is as large as water supply in urban areas. 0.1% content of soil in sewage is extremely low compared with 3% in sea water. As sewage water is abundantly available close at hand and easy to collect, it is much more cost-efficient to recycle sewage water than seawater. For this reason urban sewage water is commonly regarded as the second effective water source and one of the potent means to solve a water shortage problem around the world. In some urban areas such as Beijing, an ordinance stipulating the use of recycled sewage water and other domestic effluents for flushing in toilets was issued some 20 years ago, and has achieved positive results.

As rainwater is abundant and easily obtainable at no cost, it is called "water from heaven" in some countries, and has been used to augment water sources after processing or making it seep into the ground to suit regional conditions. By doing so would not only help save water but also decrease outflow having an effect of reducing the load on rainwater ductworks in cities.

Non-traditional water sources such as recycled water and rainwater mentioned above, have been used for circulation and a cascade as well as for toilet flushing, sprinkling, and circulation cooling in locations where no human contact is made. Some efficient water saving products have also been developed based on advanced technology. It is also feasible to minimize the amount of water used by raising the concentration rate of circulating cooling water.

3.3 Improving water supply system design

The following are some hints at improving water supply system design.

(1) Utilizing pressures generated by the water supply system water and energy saving can be achieved, and secondary pollution avoided if we obtain detailed information on the pressures inside water supply pipes at building sites and take pneumatic pressure into consideration in designing a water supply system.

(2) Controlling water pressure of pipes at terminals in multi-layered / high-rise buildings

Controlling water pressure at piping terminals constitutes a crucial point in saving water in the supply system. According to actual measurement data, the amounts of water discharged from common faucets when pressures are 0.24 MPa and 0.50MPa are 0.42L/s and 0.72 L/s respectively. However, the fixed flow rate for these faucets is set at as low as 0.15 L/s. Simple calculation shows that 19.44 million m^3 of water and 1.08 million kW/h of energy would be wasted every day in cities nationwide, if the pressure were 0.2 MPa and the flow rate were 0.15 L/s higher than the standards in 60 % of all faucets used in the existing buildings. This clearly indicates how important a role controlling water pressure at piping terminals plays in the overall water saving framework.

Maintaining a balance between water and hot water supply pressures in pipe terminals of a centralized hot water supply system by keeping a balance between water supply pressure and hot water supply pressure in two-valve mixing faucets, it is possible to reduce the amount of water used for adjusting temperature, prevent scalding, and create safe and comfortable hot water supply systems.

Ensuring circulation effects of centralized hot water supply systems centralized hot water supply systems are installed in many of apartment complexes, condominiums, second houses and public buildings that have been constructed in recent years. However, some systems use up a large amount of water (10 ~ 20 L per use) and are hardly considered to be suitable. Therefore, it is highly recommended that hot water return pipes be installed. By circulating hot water in the main drain, stack, and horizontal branch, an amount of discharge from a faucet can be reduced significantly.

3.4 Adoption of water-saving sanitary fixtures

A water-saving sanitary fixture can be defined as a fixture, installation of which can reduce the amount of water use , and at the same time meet various needs such as drinking, kitchen, toilet, bath and laundry. The main characteristics of this type of fixture consist in its capability to save water, being durable and less prone to cause leakage.

3.5 Adoption of high quality facilities, fixtures and pipe materials

Facilities that are concerned with water saving in buildings include pressurized water supply unit, receiving tank, water heater, hot water storage tank, water treatment device, and circulation treatment device. Adoption of high quality facilities, devices and materials can contribute to enhancing safety of water supply, providing stable water supply pressure, reducing water amount, and improving circulation rate.

Pipe materials, fittings and valves can become a culprit of leakage from piping. According to statistics, the rates of piping leakage exceed 10% in all urban areas of China. Although there are no statistical data showing the rates of leakage in apartment complexes and individual buildings, the amount of leakage can easily be inferred to be great from the fact that aged and deteriorated materials and valves are used, and that the quality of construction work is poor in such structures. Therefore, adoption of high quality piping materials, fittings and valves would constitute an important way to improve water saving.

3.6 Measuring volume of water consumption

Measuring the volume of water consumption can be an effective means of water saving from an economical viewpoint. Though currently water consumption is measured with water meters installed at the points where pipes are led into each building and with IC cards used in public bathrooms and shower rooms in schools, factories and companies, the meters that are high in accuracy and low in error rate should be used.

4 "Standard for Water-Saving Design in Civilian Architecture" GB5055-2010

Water saving in architecture should be given top priority in implementing the various technologies mentioned above. In order for these technologies to be successfully utilized, it is first necessary to establish an authoritative national standard for water saving design. Prompted by No. 125 of "Standard for Water-Saving Design in Civilian Architecture"] began compilation of China Architecture Design & Research Group (referred to as "The Standard" below) in May 2007 in collaboration with the Standard was officially put into practice in October 1, 2010.

4.1 Determining fixed rate amount

The figures for the maximum amount of water used in buildings in China are taken from the data in the 1950s and indicate the largest amount of water used in a day, consisting the basic data for making a decision on the kind of piping, facilities, and fixtures to be used in buildings. However, the figures in old days are no longer compatible with the current conditions surrounding water use as a result of economic growth, development in scientific technologies, expanding use of water-saving fixtures and fittings and heightened public awareness stimulated by the China's national policies for creating a water-saving society.

Therefore it is not practical to estimate annual water saving volume based on annual water use for designing that is obtained from the figures for maximum design daily volumes of water usage (GB50015-2003) has no record of the average water consumption, while the design standard for plumbing system in outside (GB50013-2006) specifies average design daily volumes of water usage for urban residents but does not stipulate how design daily volumes of water usage for apartment complexes and public buildings should be determined. "Design standard for gray water supply system" (GB50336-2002) also describes the values of average water consumption calculated from the coefficient of total change of water supply in cities, but it requires validation based on a large volume of statistical data to see if they fit the actual figures. It is most appropriate that annual water consumption be calculated based on average design daily volumes of water usage. These figures constitute an important basis for water-saving activities. In the past few years, the governmental department in charge has conducted investigation and statistical analysis on various buildings, and some research institutions have made actual measurements of water consumption. Based on the results, the daily volume of water usage index was presented. This figure is called water saving volume.

4.2 Water saving rate and use of non-traditional sources

"Green Building Evaluation Standard" (GB/T50378-2006) defines the water saving rate as the ratio of water actually saved by various saving methods including water saving facilities and the use of non-traditional sources to design total daily volumes of water usage. In residential homes the water saving rate must be 8% or higher. On the other hand, the water recycling rates for non-traditional sources in offices and commercial establishments, and hotels are established to be 20% or higher and 15% or higher respectively. The total design daily volumes of water usage is the standard, which is calculated based on the actual population or use of the building. As average design daily volumes of water usage for residential homes and public buildings are not prepared, China Architecture Design & Research Group makes calculation using maximum design daily volumes of water usage. This means China Architecture Design & Research Group is not contributing to actual application of the water saving rate.

In order for evaluation indices of water saving rate to be incorporated into "The Standard," the problems of how water saving rates for buildings with different uses should be determined, and how such indices can be applied to actual construction of buildings remain to be solved. The evaluation of recycling rate can be quantified during construction when non-traditional water sources are adopted. In recycling gray water and rainwater, recycling rates of 21% in residential homes, 60% in offices, 10% in hotels can be attainable if recycled water from non-traditional water sources is used for flushing in toilets. The recycling rates of non-traditional water sources used in sprinklers in lawns and roads, and washing cars are expected to be 10%. Therefore, the recycling rates of non-traditional water sources should be used as an index for evaluating the effects of water saving. "The Standard" includes formulas that can be used for calculating recycling rates of non-traditional water sources.

4.3 Pressure and flow rate of sanitary fixture

"Design standard on Plumbing in building" (GB50015-2003) stipulates that a pressure reducing valve or pressure controller be installed if the pressure of an incoming pipe (or a horizontal branch) exceeds 0.35 MPa. Determining optimum pressures of sanitary fixtures, that is, how much pressure should be applied without undermining comfort of use remains a critical issue. In Japan the concept of comfortable flow rates have been brought up. It refers to the optimum flow rate, which satisfies the conditions of use for a fixture under a certain pressure without causing shocks or squirting. comfortable flow rates varies for different fixtures. The standardized rates are 8.5 L/min. (0.14 L/s) for washbasins, 10.5 L/min. (0.175 L/s) for manual washing of clothes, 8.0 L/min. (0.133 L/s) for shampooing, and 8.5 L/min. (0.14 L/s) for shower. "Water saving type sanitary appliances of domestic" in standards of building construction industry (CJ164-2002) stipulates that the pressure of water saving faucets be 0.1 MPa, pipe diameter 15 mm or less, and the maximum flow rate 0.15L/s or less. In the case of a toilet bowl flushing valve with 0.3 MPa, flushing amount of a toilet basin per use is 6 ~ 8L, that of a urinal 2 ~ 4L, and flushing time 3 ~ 10 seconds. As for shower, the pressure should be 0.1 MPa, and the pipe diameter and maximum flow rate should be kept below 15 mm and 0.15 L/s respectively. Although comfortable flow rates varies for different fixtures, comfortable flow rates of various fixtures that are suited to the Chinese way of water use should be measured as it would form an important foundation for determining the pressure of the water supply system in the country. Currently the standards specify that the static pressure of each vertical line of a water supply system be 0.45 MPa or less, and that decompression devices should be installed at lower sections of the system to keep the pressure 0.2 MPa or less.

4.4 Sanitary fixtures and apparatuses

The products such as sanitary fixtures, faucets, and showers used in the water supply and drainage systems in buildings should conform to the specifications of "Water saving type sanitary appliances of domestic" (CJ164). It is recommended that western style toilet basins be equipped with tanks for flushing both large amount and small amount of water interchangeably. In residential homes flushing tanks with the capacity of over 6L should not be used. Urinary basins and Chinese style toilet basins should be equipped with timer operated auto closing flushing valves, automatic sensing valves] and foot operated flushing valves. Auto sensing or timer operated flushing valves should be installed in washbasins in public toilets. And sanitary fixtures such as washbasins should be equipped with faucets that are hermetically sealed and high in durability. It is desirable that flow control devices are incorporated into the nozzles of faucets and showerheads. In public baths where hot water supply pipes and hot water return pipes are installed, valves for mixing hot and cold water with thermo-control and display functions should be adopted. In schools, condominiums for students and dormitories, auto flow control devices should be installed in bathrooms where hot water is used. Water saving facilities with high efficiency should be installed in laundry rooms and kitchens.

4.5 Recycling of gray water and rainwater

" Code on gray water in buildings" (GB50336-2002) stipulates that in accordance with local regulations gray water processing devices be installed in buildings in drought prone cities and areas. Designing, manufacturing and using such gray water processing devices must be done in tandem with designing, construction and use of the buildings. "Technical standard on using rain water in buildings and site of apartment houses" (GB5044-2007) stipulates that prospects of rainwater use be included in planning and designing of the buildings where rainwater utilization systems are to be installed. Although the above mentioned two standards do not specify specific sizes of gray water processing facilities and rainwater utilization facilities, they do state clearly that implementation of the facilities be done in accordance with local regulations. As there are no national requirements, local governments in some cities such as Beijing and Shenzhen have established regulations concerning implementation of gray water processing facilities and rainwater utilization facilities to meet specific local situations. It remains a point of controversy whether requirements of 中水 processing facilities and rainwater utilization facilities should be applied to the whole area or limited to drought prone areas. "The Standard" specifies that rainwater utilization facilities to collect rainwater through infiltration be installed on the premises of buildings and apartment complexes. The installation of rainwater collection systems is limited to areas with annual precipitation of over 400 mm. In cities with annual precipitation of over 800 mm, roof rain capture systems should be used. If recycled water has already been utilized in the city, it should be given priority. In areas where water sources are scarce and no recycled water is supplied by the city, gray water processing facilities must be set up in the following buildings when they are constructed or remodelled :

(1) Hotels with total areas of over 30,000 m^2

(2) Offices, condominiums, and other public buildings with total areas of over 50,000

m^2 and water recovery amounts of over 100 m^3/d

(3) Residential homes with total areas of 50,000 m^2 and water recovery amounts of 150 m^3/d

4.6 Evaluation of water saving

Evaluation of water saving means the results that have been achieved after the adoption of water saving design, that is, an evaluation index and a measure of the effects of water saving for users. A water saving index should reflect many different aspects of the conditions of water saving, and various indices should be established to evaluate overall levels of water saving in buildings. With any index to be used properly, it is absolutely necessary to balance out inflow and outflow of water during a specified period of time.

An evaluation index consists of limited items, general items, priority items, and creative items. These include water saving rates as a result of adoption of water saving fixtures, non-traditional source utilization rates, cooling water recycle rates, pool water recycle rates, water meter installation rates in residential homes, and pipe leakage rates.

Research into saving water in buildings is supported by the government in creating a national water saving standard. A water saving standard can be used as legal basis for water saving campaign in buildings in China. It also serves as technological assurance in creating a water-saving society. To create a water-saving society, it is necessary to organize systematic activities, to establish related regulations and indices, and to enhance public awareness of water saving. Furthermore, engineers in the field of water supply and drainage systems need to work hard to incorporate the concepts and measures of water saving into actual construction of buildings.

5. Presentation of Author

Zhao Li is born on April, 1963.

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