

Discussion on the Water-Saving Technology of the Green Community

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Abstract: As an architectural concept, green building surveys the impact of building activities to the environment from the perspective of building lifecycle, and implements the sustainable development of the building, of which water resource is a very important factor. Combined with *evaluation criteria of the green building* in China, this paper analyzes the main existing problems of water conservation in Chinese residential communities and proposes the development orientation of the green community in our country in the future, compared with the relative technical measures home and abroad from the following four aspects: water-saving products, grey water treatment and reuse, rainwater and reclaimed water utilization.

Key words: green building; life cycle assessment (LCA); green community; non-traditional water resource; terms of reference (TOR)

1. INTRODUCTION

Many countries in the world have been taking up with the green building and advocated the ecology, environment protection and economy of buildings since entering 21century. But what is the green building? Green building should be the kind of building, which harmonizes with nature in its whole life cycle and supplies people with the health, applicable and high-efficient room through saving resource at furthest, including energy-saving, land-saving, water-saving and material-saving, as well as protecting environment and reducing pollution^[1]. From the definition of the green building, it's easy to find that green building surveys the

impact of building activity to environment on the view of life cycle, which isn't about the isolated construction entity, but manifests the harmonious unification of building, environment and people. They are interdependent and interactional and even compose a steady triangle.

Talking about the construction form of the green building, it can be divided into residential building and public building. The residential communities, as a aggregate of dwelling house, have the characteristic of unified planning and construction, perfect supporting facilities and professional property management etc. If a residential community wants to be a green community, it should be developed according to the construction standard of green building, particularly in water-saving. With the structure adjustment of water-using, the 2003 domestic water consumption ratio in Chinese cities has been reached 11.9%, yet 2% in 1980^[2], so how to alleviate the domestic water shortage effectively and improve water-using efficiency of dweller is the vital problem.

2. WATER-SAVING TECHNOLOGY COMPARISONS BETWEEN THE DOMESTIC AND FOREIGN RESIDENTIAL

All of water-saving measures originates from the thought of broaden sources of income and reduce expenditure, which is to reduce the consumption and enlarge scope of available water. The specific measures mainly include the following aspects:

2.1. Water-Saving Products

Water-saving products could be divided into two parts, indoor and outdoor, in which the indoor water-saving is the best way to settle the problems of terminal treatment. Indoor water-saving equipments mainly include toilet and tap and so on, of which toilet is regarded as the keynote, because wastewater discharged from it occupies 40% of total wastewater of dwelling. At present, water-saving toilet in China is dual flush (3/6 L) or each no more than 6 liter of siphoned flush, as well as the type of direct flush by gravity balance controller. Correspondingly, the development of water-saving toilet in foreign countries includes: one is improving the fittings of toilet by reducing consumption and synchronously assuring the sanitary and improving control level, even water used for toilet directly coming from hand washing or existing water supply pipe without tank; two is renovating toilet to separate feces and urine individually by pipe and to make compost at last; and third is making use of renewable energy namely solar energy to support electric controller of toilet and even integrated utilization.

Water-saving equipment outdoors in residential community mostly refers to the irrigation. Green ratio of residential community must be satisfied with 30% for new and 25% for rebuild at least in China. The outdated flooding irrigation is neither economy nor advantage for plant growth due to water distribution asymmetry, drip and spray used in agriculture irrigation are introduced into urban. Drip irrigation is good at water-saving because water contacts directly with soil without sprayed in the air, especially using non-traditional water resource, and avoids the danger of people contacting with reclaim water. But good water quality required, drip is restricted by initial investment and some technical problems that filter and dripper jam caused by negative pressure of water break and so on. Nowadays, the spray and micro-spray irrigation in portable-type and semi-fixed type are popular in our country because greenbelt in residential community is a movement place for people. Except for promoting drip irrigation, the irrigation with low-pressure and soil moisture meter installed to reduce inefficiency spraying is considered for saving energy and automatization

control.

2.2. Grey Water

Grey water treatment and reuse is being regarded as an effective way in residential community to increase the value of wastewater on-site. Grey water occupies 60-70% of total of house discharge and also belongs to domestic sewage. Its treatment methods are the conventional processes used in waste water treatment plant (WWTP) like Bio-contact Oxidation, RBC, BAF, SBR and new process, such as UASB, Bio-fluidized Bed Reactor^[4], CASS^[5], etc. But such techniques still have their limitation. The advanced bio-treatment for grey water is necessary in order to ensure the water quality of reuse, as the result of non biodegradable fraction that COD:BOD ratio were generally lower in the bath (2.9 ± 1.3) and shower samples (2.8 ± 1.0) and in the hand basin (3.6 ± 1.6) but typical domestic sewage (2.2 ± 0.6)^[6], and the problem of environment protection due to the dwelling area impacted, as well as the construction and operation cost of on-site WWTP beyond urban infrastructure will be taken by owner.

Constructed wetland and membrane biology reactor (MBR) is recommended for on-site WWTP constructed in residential community. Constructed wetland removes contamination utilizing making use of dual action of plant and media by modeling nature ecosystem, without labor management, and it yields on economy and environment, of which fancy plants grow, such as Reed, Calamus, Ducktongue Grass and Cannas. Constructed wetland, particularly for the horizontal and vertical subsurface flow systems, generally associates with biological process to treat grey water. Whereas, MBR not only could solve the problems of large floor area and out-of-service in winter of wetland, but also is directly used to treat domestic sewage which water quality is stabilization and even beyond the water standard of non-potable reuse. Except these, MBR generally applied in America and Japan also is from other advantages that it isn't subjected to the outside condition and easily implements PLC^[7]. With the development of new membrane material, the primary investment and

membrane pollution are being solved.

2.3. Rainwater

Rainwater utilization has a long history, which had once considered as an important drinking water resource before water supply facility was set up. With the rapid progress of urbanization and civilization, rainwater was ever discharged by pipe as waste. However, Germany, Japan and Israel have paid much attention on the utilization of rainwater in the middle of last century; they promoted using rainwater for irrigation and non-potable use so as to control nature water pollution and supply increasingly, and completed corresponding policy and technical measures. Filtration and store are the available paths of rainwater using all over the world.

2.3.1. Infiltration

Infiltration of rainwater mainly depends on hydraulic cycle to enhance relative moisture of soil. As a indirect means for saving water, it not only releases the load of storm sewer, but also pre-treat rainwater through plant and soil to cut off contamination carried in storm, particularly cities in north of china having the annual average rainfall below 600mm. Infiltration should be adopted according to local geology condition, which effectiveness will be influenced by permeability coefficient of soil greater than 10^{-5} m/s and groundwater level exceeded 1m in our country.

In general, system assembles green billabong, permeated pavement, underground penetrate pipe and dry well etc. As we know, impoundage of nature billabong individually is sand ground (5mm), clay (3mm), grass (4-10mm) and cement (1mm)^[9]. Representative of infiltration system has:

MR system: It prevailing in Europe is to lead rain into shallow ditch covered with grass. At first, storm water stops in the ditch and infiltrates into underground, and then the exceeded load flows off penetrate channel located roadside. The system with the max-depth of 0.3m strengthens the capability of infiltration by integrating infiltration of short-term of shallow ditch and of long-term of channel availability and solves the problems of excessive groundwater

level or high humidity of soil in short period^[10].

Concave Greenbelt^[4]: Correspondingly, it is applied popularly in large city of north China and also utilizes the shallow ditch through adjusting the level of green, roadway and storm inlet. The storm inlet is installed in greenbelt, which level is below roadway and above greenbelt. The storm inlet locating in greenbelt isn't impacted by people and vehicles, and it can be equipped simply and has a lower cost.

2.3.2. Store Water

As a mode of social recycle of rain water, store adopt to the area of having ample rainfall by collecting excessive storm water after saturated infiltration. The way of store includes: green roof: It catches 70~90 percent of rain depending on plant and soil media, which runoff coefficient is about 0.3 compared with 0.9 for the ordinary. Plant namely crassulaceae growing on the roof controls rain pollution at source effectively and improves micro-climate of residential and builds a favorable stereo landscape synchronously. collecting basin: One way is to build a collecting basin in big size under lawn and public square or to make use of water body in residential. The other is to be equipped with the self-contained system working through downspout, device for discharging the preliminary rain carrying with vast pollutant, filter, collecting basin underground of in house and pump supplying treated rain for flushing toilet and washing machines and hot water yet. With respect to the cost and limited collection, the self-contained system only can be used for villa and townhouse.

As a system, design of storm water engineering involves many aspects, such as service area, local climate and geological condition as well as process and equipment selected. Algorithms of diagrammatize, empirical formula and max-value^{[11],[12]} are adopted to calculate infiltration ditch and channel underground.

2.4. Reclaimed Water

Reclaimed water is the kind of water coming from WWTP through advanced treatment, including

coagulation, sedimentation, filtration, reverse osmosis(RO), granular activated carbon(GAC)and UV disinfection, and its quality should meet the requirements for wastewater reuse and ordinarily better than that of on-site reuse system. Regional recycle changes the liquidity in one-way and makes wastewater as a source available for the non-potable water use. In American, reclaimed water is divided into four grades ABCD according to treatment process and numerical of total coliform organisms, and user selects reclaimed water with different grade depending on his purpose^[13]. The yield of reclaimed water of Beijing had produced 80 million ton in 2003, and it is mainly supplied for municipal works and industrial works. Because the supply system of reclamation hasn't brought into urban planning, multiple-purpose utilization of reclaimed water couldn't be achieved in our country.

3. EXISTING PROBLEMS OF WATER-SAVING IN CHINESE RESIDENTIAL COMMUNITY

The problems of water-saving in our country are exposed by contrasting measures executed in home and abroad.

1. Concept transition. The work efficiency and cost of project is related with local influencing factors considered including climate and geology and life habit of target groups and the size of adjusting tank will be determined by time fluctuate and season change of water use of dweller, but calculation of water balance mostly is behind master plan, and pondage of waterscape is limited because the area is always confirmed during the layout period. Correspondingly, the work of TOR is paid much attention in foreign, which is to define the project goal at first, and the following work putting into practice, such as master plan and primary and construction document design, must be complying with these goals.

2. Technology. According to the analysis of Beijing Municipal Research Institute of Environmental Protection, the construction of reclamation project is appropriate while all of the people inhabiting a specified area for each 10

thousand or the reclaimed water demand is 750 ton per day over^[14]. So wastewater reuse isn't adapted to all community. As a sustainable building, IJburg estate project of Netherlands constructed in 1996 planed its water-saving scenario according to LCA (e.g. economy, environment impact, standard of technology and acceptance by the public)^[15]. In general, technology applied should be given a overall consideration on the basis of local condition^[15].

3. Reclaimed water quality. Wastewater reclamation has been developing in recent years, which treatment technology still is faultiness, particularly in safety and emergency. Water quality index only relates to coliform organisms without biology, virus and pathogeny etc. When grey water treated together with rain and the reclaimed water applied to irrigation and water landscape, people health will be threatened.

4. Technology criterion. Parameter referring to municipal WWTP processes will be unsuitable for the grey water with a large number of LAS and higher temperature and alkalinity than domestic sewage, and nutrient substance namely nitrogen and phosphorus useful for plant growth removed during the period of treatment. Our country has published some standard, such as *domestic water-saving products*(CJ164-2002) and *Code of design for building reclaimed water system*(GB 50336-2002) and *water quality standard of non-potable use*(GB/T18920-2002)and *Code for design of wastewater reclamation and reuse*(GB 50335-2002), and is establishing Engineering technical code of Rainwater Utilization in Building and Sub-District, but hasn't any relevant reference about grey water treatment.

Besides, economy also restrains the implement of technology. Contrasting with conventional building, green building's increase cost per cubic meter is approximately 400 RMB in China, of which 10 percent is attributed to water-saving. Respect to the developer without the ability to take over property management, his investment will not return probably.

4. DEVELOPMENT ORIENTATION OF THE GREEN COMMUNITY IN OUR COUNTRY

At present, green community of our country is underway and needs to develop further. Therefore, the green building referred to evaluation criteria of green building in china is divided into three grades, which purpose should be to construct special building depending on current technology and economy. The development of multi-object use of resource, technology integration and serialization and standardization of product will be satisfied with the embodied feature with green building, low cost and consumption, high efficiency, protecting environment and public health.

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