高等院校土建学科双语教材（中英文对照）

◆给水排水工程专业◆

水循环系统

WATER CYCLES

[德] 桃丽丝·哈斯-阿尔恩特 编著

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CONTENTS

中文部分目录

序

对于发达的工业化国家，饮用水*是一个建筑所必须具备的基本条件。然而，饮用水是一种非常重要的日用品，而且在世界的许多地方非常稀缺。不仅对于工业化国家，对于消费者而言，饮用水的收集和处理成本越来越高。同时，由于废水中所含的污染物质，废水的排放和净化越来越复杂，同时也需要消耗越来越多的资源。

对于建筑师而言，饮用水和废水之间存在一点共同之处——在进行建筑设计的时候，非常重要的一项内容就是饮用水和废水的布置、使用以及排放。饮用水和废水管道系统的布置以及相关的技术需求将对厨房、卫生间的区域造成一定的影响。避免饮用水的过多消耗是在进行建筑设施设计时的一项重要内容。

在对一栋建筑进行设计的时候，必须对如何减少水的消耗的可能性和要求等问题有一个根本性的了解，其中最重要的是要对不同因素之间的相互联系和影响以及相应的技术问题进行了解。在设计时，需要把建筑中的水循环考虑到整体设计中。

本书主要是针对建筑学专业的学生以及没有建筑设备相关知识背景的毕业生而编写出版的。书中还附有一些易懂的说明和解释，能够帮助读者逐步理解本书内容。本书对建筑中不同部位的水管道进行了描述，同时还对它们的功能和技术需求做了讲解，并帮助读者在实际的设计过程中更好地理解它们之间的相关关系。

编辑　伯特·比勒费尔德（Bert Bielefeld）

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* 原书为 drinking water，但我国所称饮用水是指自来水经过深度处理后的直饮水。而自来水厂供给的冷水，虽然符合饮用水标准，但一般称给水，不叫饮用水。本书保留原文的直译，称为饮用水。——编者注

FOREWORD

The availability of drinking water in buildings is taken for granted in developed, industrialized countries. Drinking water is, however, a valuable commodity, and is scarce in many parts of the world. The collection and treatment of drinking water are becoming increasingly expensive for industrialized countries and therefore also for the consumer. Similarly, the disposal and cleaning of waste water are becoming more resource-intensive and complex due to the substances it contains.

The interface between the drinking water and waste water is the distribution, use and disposal of water within buildings, a significant component of the architect's design. The arrangement of supply and disposal pipework and the technical requirements influence the location of sanitary and kitchen areas. Avoiding high water consumption is an important aspect of technical building services planning.

A broad knowledge of the requirements and possibilities for reducing water consumption is necessary to be able to take these key topics into account in the design of a building, right from its inception. This includes, above all, an understanding of the interrelationships and dependencies, as well as technical systems. It is important to think of the water cycle in a building as an integral part of the design.

The volume *Basics Water Cycles* is aimed at students of architecture and recent graduates without previous knowledge of building services. With the aid of easy-to-understand introductions and explanations, the reader is taken through the subject matter step by step. The path of water through the various zones of a building is described and related to their specific roles and requirements, so that students are able to fully understand the interrelationships and introduce them into their own designs.

Bert Bielefeld, Editor

INTRODUCTION

Part of the technical services in a modern building is a complex pipework system for supplying drinking water and disposing of waste water. This system is a cycle, somewhat similar to the natural water cycle: fresh water is collected, supplied to the building, distributed through a pipework system, and heated if required. It is piped to the draw-off points in bathrooms, kitchens and other sanitary rooms. As soon as it leaves the drinking water pipe through the faucet, it becomes waste water and flows through the waste water pipework into the sewers, from where it is cleaned again and finally returned to natural watercourses. Architects must integrate this cycle into the design of their buildings, as without a carefully planned and properly functioning fresh and waste water system, WCs cannot be flushed, washing machines cannot be operated, and no water will emerge from a shower.

The chapters that follow consider the individual positions of water in a building along the water cycle, and describe the functions of the elements connected to this cycle. It should become clear how a drinking water supply system works, how it is designed into a building, and which aspects should be taken into account. There is also an explanation of how waste water is created and conducted into the drainage system, the general problems that arise in the supply and disposal of water, and the options for their solution.

Approximately two thirds of the earth's surface is covered with water. Of this, only 0.3% is fresh water and therefore potential drinking water. Drinking water is very high-quality fresh water that is suitable for human consumption.

THE NATURAL WATER CYCLE

The natural water cycle—or hydrologic cycle—is a continuous sequence of evaporation, precipitation, and rainwater draining into bodies of open water or seeping into the ground to accumulate as groundwater. Water vapor rises under the influence of solar radiation or other heating effects to form clouds, and falls as precipitation back onto the earth's surface. Some of the rainwater that seeps away is absorbed by the ground, some evaporates, and some is taken up into plants by capillary action. A proportion reaches the lower soil strata and helps maintain the groundwater table. › Fig. 1

Groundwater

Groundwater is described as precipitation water that is stored on top of an impervious stratum and has a temperature of between 8 and 10 °C all year round. Groundwater is generally microbe-free and is pumped up to the surface from deep wells. It provides about three quarters of our drinking water, and goes through several stages of cleaning and filtering before it is fed into the public supply network.

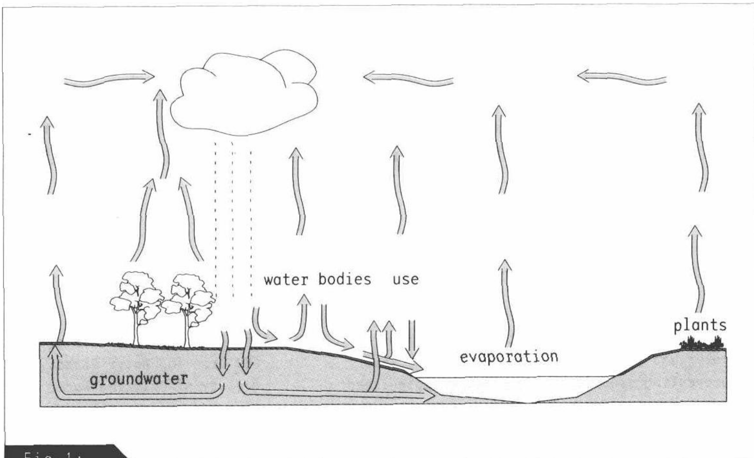

Fig. 1:
The natural water cycle

Substantial groundwater extraction and extensive sealing of urban land surfaces have a substantial impact on the natural water cycle. Rainwater falling on impervious areas cannot seep naturally into groundwater, but is conducted directly into bodies of open water or into the drains. The groundwater table is greatly reduced by building developments, deforestation and drainage works.

In addition, the extensive extraction of groundwater for agriculture and industry, and the pollutants that these activities introduce, are harmful to the system. Pollutants from sources such as manure, agricultural pesticides, landfill, highway drainage and industrial emissions, which fall as acid rain and seep into the groundwater, are a serious cause for concern and can be removed only by expensive cleaning and filtering. The increasing contamination of water combined with high water usage produces an ecological imbalance, the consequences of which result in high costs.

STANDARDS FOR DRINKING WATER

Drinking water intended for human consumption has to meet certain standards. It must be good to taste, odorless and colorless, and free of pathogens and microbes. Every draw-off point must provide best-quality drinking water at sufficient pressure. Quantities of chemicals added to disinfect the water, and of other possible constituents, must be kept within limits specified for European Union countries by an EU directive and regional drinking water regulations. The water's quality and the limits for the substances it contains are checked regularly in accordance with the applicable national standards for drinking water. These standards for drinking water quality change constantly. Today's level of pollution means they can be met only with great difficulty and at increasing cost.

Hardness level

Water with high calcium and magnesium content is described as hard, while water with low calcium and magnesium content is soft. High levels of hardness produce a build-up of mineral deposits in pipe networks; these deposits are known as scale. Considerably more detergent is required for washing clothes in hard water, and the dishwasher may leave

\\ Note:
Surfacings such as asphalt are impervious to water and effectively seal the ground, thus preventing groundwater from being replenished.

\\ Note:
The European Union Council Directive 98/83 (EU Drinking Water Directive) concerns the quality of drinking water for *human consumption* and obliges all member states to implement it stepwise into their national legislation.

Tab. 1:
Water hardness ranges

Hardness range	Hardness in mmol/l	Description
1	<1.3	soft
2	1.3-2.5	medium hard
3	2.5-3.8	hard
4	>3.8	very hard

a thin film of lime on the dishes. Water hardness is measured in mmol/l (millimoles per liter). The hardness level depends on the source of the water. › Tab. 1 Water with less than 30 mg/l calcium bicarbonate, on the other hand, does not allow the pipes to form a protective surface layer, with the result that the pipe material is attacked by acids, and corrodes. The effect of water hardness on health is insignificant.

pH

An important measure of the "aggressivity" of water is its pH (Latin: *potentia Hydrogenii*). The pH describes the concentration of hydrogen ions in water, or more precisely: the negative logarithm of the hydrogen ion concentration. On this scale, pure water has a pH of 7, i.e. there are 10^{-7} g H ions in one liter of pure water. If the pH drops below 7, the water behaves aggressively like an acid; if the pH is higher, the water behaves as a base (alkali) and more lime is deposited.

THE DEMAND FOR DRINKING WATER

In the 19th century, Germany required about 30 l of drinking water per day per head for consumption and personal hygiene. Today, by contrast, the figure will soon reach 130 l, due to the increasing levels of sanitary convenience, such as flowing water, showers and flushing toilets. This consumption is doubtless very high, but it has already decreased, because a great number of water-saving fittings have been installed in bathrooms and WCs in recent years. However, industry, commerce and agriculture are using increasing amounts of water. The irrigation of agricultural land consumes the largest quantity of drinking water worldwide.

In the industrialized countries, almost all buildings are connected to the public drinking water supply network. Many billion cubic meters of water are removed from the natural water cycle for drinking water supplies every year. Most of this comes from groundwater and bodies of open water, and the rest from sources such as river bank filtration. The term "bodies of open water" refers to rivers or lakes, the water of which is usually contaminated with bacteria and mechanically eroded solids, and can be supplied as drinking water only after a long purification process.

Conurbations and regions where water is scarce have to rely on some of their drinking water being transported from far away. At the same time, the high proportion of impervious surfaces in cities means most of the rainwater flows directly into their drainage systems. As it is particularly difficult to supply the quantities of drinking water required in these areas, it is imperative to reduce drinking water demand.

The daily drinking water demand of domestic households can be divided into different uses. The amount actually consumed is quite a small proportion of the total. Only about 5 l water are drunk or used for cooking, and the rest used for other purposes. Peaks and troughs during the day are compensated for by water storage at waterworks.

The average hot water demand in domestic residential properties is between 30 and 60 l per person per day. It can vary greatly from day to day and with the habits of the users. A bath requires about 120 to 180 l hot water at 40 °C; a 5-minute shower about 40 l at 37 °C. Energy and drinking water can be saved by choosing to have a shower instead of a bath.

SAVING DRINKING WATER

Today there are many sanitary engineering solutions for saving drinking water: flow limiters in shower heads, water-saving faucets and toilets, and domestic appliances (e.g. washing machines and dishwashers)

Tab.2:
Typical usage of drinking water

Activity	**Usage in l/day/person**
Drinking and cooking	5
Basic personal hygiene	10
Baths and showers	38
Dishwashing	8
Cleaning	8
Clothes washing	15
Toilet flushing	40
Garden watering	6
Total	**130**

with reduced water consumption. Installing a water meter in each apartment instead of having one central metering point in the basement has a proven water-saving effect, because users can track their consumption directly; they just pay for the water they have used. WC cisterns with stop buttons and a water usage of 4–6 l per flush are now standard. More advanced systems such as vacuum toilets use 1.2 l water per flush. Composting toilets of various types use no water at all. › Chapter Drinking water systems in buildings, Sanitary rooms

A more accurate analysis of drinking water usage makes it clear that water of drinking water quality is required for only the smallest proportion of the total amount supplied. › Tab. 2 Pure drinking water is necessary only for personal hygiene, washing kitchenware, cooking and drinking. Rainwater-quality water is adequate for toilet flushing, cleaning, or watering the garden. Water consumption can therefore be substantially reduced by using rainwater. Cleaned gray water from showers and hand basins, for example, can also be used for flushing WCs. › Chapter Waste water, Uses of waste water

Merely installing modern water-saving faucets in sanitary rooms can reduce average drinking water demand to about 100 l per person per day. With a few more of the measures mentioned above, it would even be possible to manage on half of normal drinking water consumption with no significant loss of comfort.

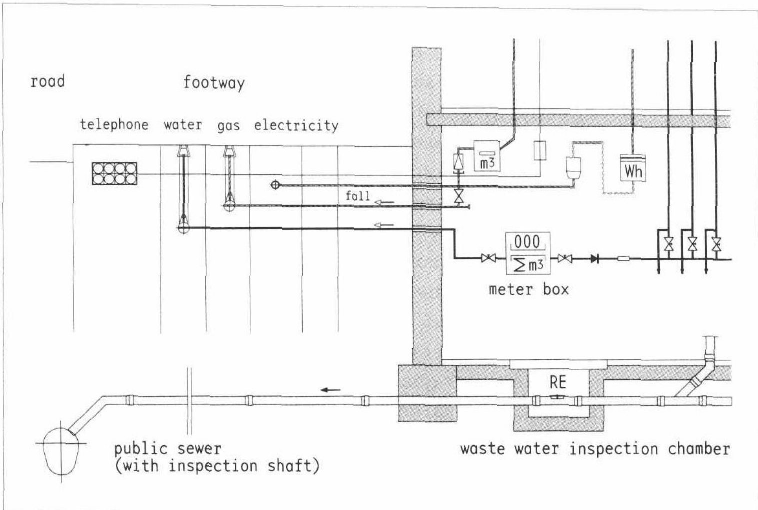

Fig. 2:
Supply and discharge pipes in a building

DRINKING WATER SYSTEMS IN BUILDINGS

The water cycle normally begins in buildings with the supply of cold drinking water through a pipe connected to the public water supply network, unless the plot has its own private supply (well). In larger towns and settlements, the connection to the public drinking water supply is normally at a frost-free depth of between 1.00 and 1.80 m below the sidewalk. Each plot has its own drinking water service pipe, which heads off into the building at right angles to the public supply pipe, as far as the house connection or main stopcock and water metering point. › Fig. 2 In residential properties this pipe has a nominal diameter of about 25 mm (DN 25). ›

In some European countries, the position of the drinking water connection is marked with a colored sign on a nearby house wall for ease of identification and location of the connection point. The lines and numbers on the sign give the distance to the drinking water connection—from the sign—and the direction (to the right, left, in front or behind). The other abbreviations normally describe the type of connection; the accompanying numbers give the nominal internal pipe diameter.

Water temperature

To prevent microbes from flourishing, the drinking water supplied to the building is cold, i.e. between 5 and 15 °C. To obtain hot water, the