DOMESTIC POLLUTION

Chen Jining
Department of Environmental Science and Engineering, Tsinghua University, Beijing, China

Keywords: Municipal effluent, municipal wastes, disposal standards, municipal waste disposal and management, wastewater treatment technologies, municipal waste treatment technologies, wastewater reuse, waste reduction, reuse and recycle

Contents

Summary

Like industrial and agricultural activities, urban life can generate significant amounts of pollutants, and is one of the major pollution sources leading to the degradation of ecosystems. Adequate control of domestic pollution is thus required to safeguard the public health and urban life quality. Broadly, domestic pollution includes domestic sewage and solid wastes. Because of the similarity of human life, the characteristics of municipal pollution share the same pattern, though the generated amounts and compositions can be varied between different countries and regions.

Strategies for controlling domestic pollution have been quite successful in developed countries, yet are facing considerable economic constraints in developing countries. Over decades' application, both disposal standards and control technologies of domestic pollution have been well developed. Although there are a substantial number of technologies available for reducing pollution loads from domestic pollution, the emphasis is now largely shifting from "end-of-pipe" treatment to integrated management of urban environmental system. This has thereafter promoted the application of treated wastewater reuses and the application of the three "R" principles in municipal waste management, i.e., reduction, reuse and recycle before final disposal. Broadly, technologies for removing pollutants from wastewater mainly include physical, chemical, and biological treatment processes. For the control of solid wastes the mainstream technologies include landfill, incineration and composting.

1. Introduction

Like industrial and agricultural activities, urban life can generate significant amounts of pollutants, and is one of the major pollution sources leading to the degradation of ecosystems. Adequate control of domestic pollution is thus required to safeguard the public health and urban life quality. Broadly, domestic pollution includes domestic sewage and solid wastes. Because of the similarity of human's life, the characteristics of municipal pollution share the same pattern, though the generated amounts and compositions can be varied between different countries and regions.

Due to over decades' successful control in developed countries both disposal standards and technologies of domestic pollution have been well developed. It is fair to say that the effective control of domestic pollution has been the dominant factor for improving the environmental quality in developed countries, and is of major implication to the environmental management in developing countries. This article is directed towards the discussion of domestic wastewater and solid wastes. It began with the summary of the characteristics of domestic wastewater and solid wastes. The focuses are then turned to discussions of disposal of domestic wastewater and wastes respectively. Due to the importance of reclaimed wastewater as an alternative water resource, reuses of domestic wastewater are also presented herein.

2. Characteristics of Domestic Wastewater

Domestic wastewater is a combination of effluents from residences, commercial buildings, institutions and similar facilities. The non-consumptive portion of water used in an area constitutes most of the domestic wastewater. It is generated from kitchen, bathroom, laundry, lavatories, toilets, garbage grinders, dishwashers, washing machines, and water softeners. As a by-product of life and living processes, its characteristics are strongly associated with the life-style and population of the served area, and the time of the year.

In general, variations of both domestic wastewater flow and composition follow hourly, daily, weekly and monthly lifestyle patterns of the serviced residential customers. Figure 1 presents a typical hourly variation of wastewater flow and pollutants over a 24-h period. The hourly peak flow rate is often 50 percent higher than the average twenty-four hour rate, and the maximum hourly load can be at least twice the average hourly load. Although these numbers will vary with locality, such a pattern is not unusual since the daily cycle of human life is more or less the same over the world. But as the sewer system and the service population expand, the impact of domestic population becomes less pronounced in terms of peak to average and minimum ratios of both quantity and pollutant loads.

Both the flow and composition of domestic wastewater can be predicted reasonably well. They are usually quantified either through direct measurements or by model estimation. Public water-supply records can also be applied for estimating flow rate. It is important to note that some water is not converted into sewage, however, due to evaporation, transpiration, and consumption. In most cases, this water is lost via pipe leakage, street washing, lawn sprinkling, and fire fighting. Studies revealed that, leaving aside infiltration of groundwater, approximately 20–40 percent of the total quantity of water supplied in a residential area is consumed, and the remaining 60–80 percent is discharged to the sewer as municipal effluent.

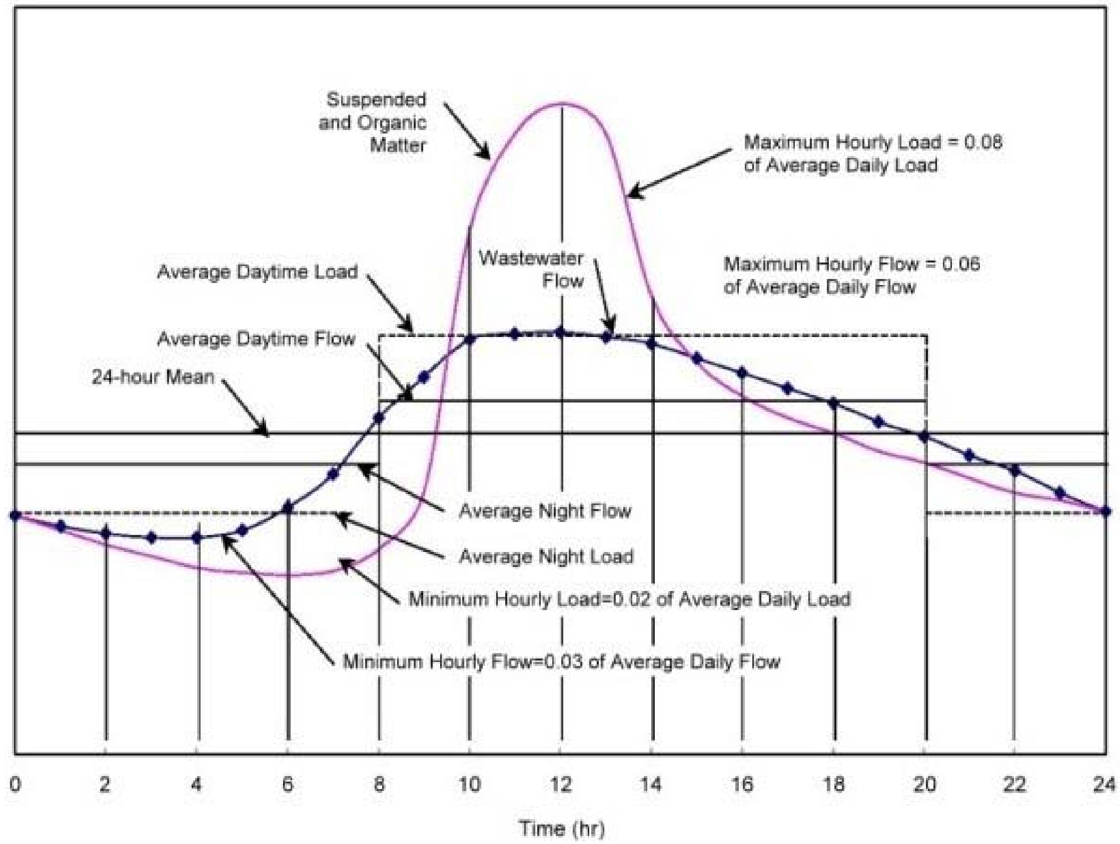

Figure 1: The typical hourly variation of Municipal wastewater flow

When modeling domestic wastewater flow rates and pollution loads, two elements are crucial: the population and the per capita sewage contribution. Population can be reliably estimated in most areas except in holiday resorts or rapidly urbanizing cities. Per capita sewage flow rates and loads, however, show wide variations across different areas. The flow rate, for instance, is less than 200 l/day in France, the UK, and Germany, but can be more than 400 l/day in North America. Variations are due not only to location, climate, community size, water pricing, and water-metering coverage rates, but also to such factors as living standards and lifestyles, water infiltration from collection pipes, and the extent of in-house water re-use. With increasing use of such modern household appliances as garbage grinders, dishwashers, and washing machines, there has been a clear upward trend in domestic water use, though this tendency depends to a large extent on the availability of water in the given community. Plenty of literature is available for considering flow rates and concentrations of different water use components in detail, as presented in Tables 1–4.

In general, the major concerned pollutants of domestic wastewater include suspended solids, organic matter measured as BOD5, COD, or TOC, microorganisms, pathogens, nutrients, coliform bacteria and refractory organics. Their major local effects are the epidemical potential to public health, the deterioration of water quality in the receiving water body, the restrictions on the possible uses of the water, and the urban life quality. Nowadays, the worst problems are posed by organic matter, which can cause depletion of dissolved oxygen and the development of septic conditions. This may kill fish, and lead to the loss of ecological and aesthetic value in a watercourse. Pathogens, indicated by coliform bacteria, used to be extremely hazardous to public health, since they are capable of causing diseases such as typhoid and paratyphoid fever, dysentery, diarrhea, and cholera. They are becoming less concern due to the significant improvement of urban infrastructures, but are still a major problem in less developed countries. Concern about nutrients is increasing and is largely due to the manner in which they increase the growth rate of aquatic plants and algae in slow-moving waters. Excessive growth of plants (particularly unicellular phytoplankton) is called eutrophication. Eutrophication may interfere with the use of water by clogging water-intake pipes, changing the taste and color of water, and causing the rapid buildup and decay of organic matters, and eventual loss of fish and other aquatic species.

Types of establishment	Liters per person or unit per day
Small dwellings and cottage with seasonal occupancy	190
Single family dwellings	285
Multiple-family dwellings (apartments)	227
Rooming houses	150
Boarding houses	190
Additional kitchen wastes for nonresident boarders	38
Hotels without private baths	190
Hotels with private baths (2 persons per room)	227
Restaurants (toilet and kitchen wastes per patron)	26-38
Restaurants (kitchen wastes per meal served)	9-11
Additional for bars and cocktail lounges	8
Tourist camps or trailer parks with central bathhouse	132
Tourist courts or mobile home parks with individual bath units	190
Resort camps (night and day) with limited plumbing	190
Luxury camps	380-570
Work or construction camps (semi-permanent)	190
Day camps (no meal served)	57
Day schools without cafeterias, gymnasiums or showers	57
Day schools with cafeterias, but no gymnasiums or showers	75
Day schools with cafeterias, gymnasiums or showers	95
Boarding schools	285-380
Day workers at schools and offices (per shift)	57
Hospitals	570-945
Institutions other than hospitals	285-475
Factories per person per shift exclusive of industrial wastes	57-132
Picnic parks (toilet wastes only, per pick-nicker)	19
Picnic parks with bathhouses, showers and flush toilets	38
Swimming pools and bathhouses	38

-

-

-

Bibliography

Corbitt, R. A. (1989). Standard Handbook of Environmental Engineering. 1281p, New York, McGraw-Hill. [This book presents a systematic overview of the design and operation of wastewater treatment facilities.]

Enger, E. D.; Smith, B. F. (1997). Environmental Science: A Study of Interrelationships. 431p, Dubuque, IA, McGraw-Hill. [A general textbook for environmental science.]

Tchobanoglous, G. 1979. Wastewater Engineering: Treatment, Disposal, Reuse. 2nd edn. 920p, Beijing, McGraw-Hill. [Description of wastewater treatment methods.]

Tchobanoglous, G.; Theisen, H.; Vigil, S. (1993). Integrated Solid Waste Management. Solid Wastes: Engineering Principles and Management Issues. 908p, Beijing, McGraw-Hill. [This book illustrates the principles and facilities involved in the field of integrated solid waste management.]

Biographical Sketch

Jining Chen is Professor and Head of the Department of Environmental Science and Engineering at Tsinghua University, Beijing, Peoples' Republic of China. Professor Chen holds an honorary first degree in Environmental Engineering from Tsinghua University (1986) and a Ph.D. in Environmental System Analysis from Imperial College, London (1993). His current research interests include environmental systems analysis; identification of environmental models; water resources and environmental policy; integrated river basin planning and management; non-point source pollution control; and sustainable cities. He is presently a member of the governing boards of several Chinese technical associations, including the Chinese Environmental Engineering Society Deputy, of which he is Deputy Chairman. He is also a member of the scientific committees of several environmental journals.