NON-CONVENTIONAL SEWERAGE

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Summary

Conventional wastewater collection systems are installed to remove human wastes from households in cities and urban areas. This system demands high water supply rates as the wastes are flushed through pipes using water that flows under gravity. This system is capital extensive, and has been found to be not suitable in urban areas with smaller population sizes. Also, for the same reason, not suitable for urban areas of developing countries, where the water supply rates also are low.

Alternative sewage collection technologies are needed on grounds of cost, construction skill, water supply availability and long-term sustainability. Initial developments of less costlier wastewater collection alternatives focused on changing the flowing conditions of wastewater in the sewers. Pressure sewers and vacuum sewers are the results of such developments. However, the wholesale adoption of sewers that collect wastewater under pressure or vacuum is not considered appropriate because of the operation and maintenance problems.

In developing countries, where the suitability of non-conventional collection systems will mainly be decided by the affordability in low-income populations in these countries; highly mechanized and maintenance-intensive systems such as pressure sewers and vacuum sewers will not be appropriate. Therefore, attempts for non-conventional wastewater collection systems in developing countries revolved around modification of conventional design standards, improved low-cost materials for construction, etc. Simplified sewers and settled sewers are prominent examples of such non-conventional systems.

1. Introduction

Historically, it has always been difficult to dispose of human wastes in an environmentally sound manner. The recorded progress in overcoming this difficulty between the pre-Christian solutions described in the literature and the mid-19th century municipal wastewater collection systems, is very little. With the discovery late in the nineteenth century that city squalor caused diseases, the solution provided by on-site disposal systems was found grossly inadequate for densely populated urban settlements that were growing by the day due to industrial revolution. The urban authorities protected the people from epidemics by removing the human wastes from households with huge quantities of water and the resulting sewage was transported through open sewers. These open sewers were eventually directed to the stormwater collection drains, leading the authorities to adopt a "combined water carriage sewer system" and later a "separate or sanitary sewer system" that excluded stormwater. These conventional sewer systems, with steep gradients that use water as the flushing agent thus came to be installed to swiftly remove human excreta before it started to putrify.

For the last 100 years, this has been the norm for wastewater collection from cities and the on-site disposal practices were continued in rural areas. With rapid population growth, rural areas fast developed into smaller urban settlements or towns, where the on-site systems started to fail, because of unsuitable soil for soil-absorption systems, faulty design, poor construction or user neglect. The stricter environmental standards that have to be adhered to by the on-site systems, placed a lot of pressure on the users of these systems as they had to undertake a high level of maintenance care, leading to a demand for a public facility as found in large cities, namely the conventional sewer system. However, it has been found that due to lower population densities of smaller urban settlements they required longer sewer lengths per connection leading to unaffordably high construction costs. By the early twenty-first century, more than half of the world's population is predicted to be living in urban areas. This proportion is expected to rise to 60 percent by the year 2025, comprising some 5 billion people. Most of such increase will be as peri-urban settlements adjoining existing large cities and the growth of rural areas into towns. This phenomena is observed to be more prevalent in developing countries, where more than two-thirds of the population is already lacking adequate sanitation. Apart from high capital costs, inadequate supply of water in these urban areas will preclude the possibility of conventional sewer systems. It has been calculated that communities with conventional waterborne sewerage normally require about 75 L of supply of water per capita per day compared with around 20–30 L available in such urban settlements of developing countries. Alternative sewer technologies are therefore increasingly needed on grounds of cost, construction skills, sustainability, and water availability.

2. Development of Non-conventional Sewage Collection Systems

In response to this problem of technological alternatives to conventional sewers, many non-conventional sewer systems have been developed. Initial developments of less costlier alternatives for smaller and sparsely populated urban settlements of industrialized countries have focused on changing the motive force and/or the characteristics of the wastewater collected. Important among the systems so developed are:

(i) Pressure sewers.
(ii) Vacuum sewers.

These systems achieved cost-effectiveness partly because of their suitability for their economy at smaller scales of operation and partly because of transferring the costs of installation and maintenance to the users. Conventional sewerage still remains the best option for the densely populated large cities of these countries. The case with less developed countries for their need to develop alternative sewage collection systems is different. The suitability of any non-conventional sewage collection system will mainly be decided by the affordability by low-income populations in their cities and other urban centers. Therefore, attempts to develop non-conventional systems in these countries revolved around modification of conventional design standards based on hydraulic theory, improved low-cost materials, etc., while retaining the gravity flow conditions of the conventional sewer. All-round reduction in installation and operation and maintenance costs of sewers were achieved by adopting design modifications such as reductions in minimum depth, minimum pipe size, minimum gradient of pipe, changes in service connections. Saving in capital cost has been achieved by one or more of the following:

- use of smaller diameter pipes;
- laying pipes at flatter gradient;
- laying sewer at shallow depth;
- laying sewers within plots at the rear of the premises;
- providing interceptor tanks for settlement of solids.

Significant among such non-conventional systems are:

(i) Simplified sewers.
(ii) Settled sewers.

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Biographical Sketches

M. Sundaravadivel is an Environmental Engineer with the Central Pollution Control Board, Ministry of Environment and Forests, Government of India. He holds a Bachelors Degree in Civil Engineering and a Masters Degree in Environmental Engineering. He has been working in the field of environmental management and industrial pollution control since 1989, particularly in the area of environmental audit, waste minimization and cleaner production in agro-based industries. He has also been an engineering consultant for planning, design and development of wastewater collection and treatment systems for many large cities of India. Currently, he is engaged in research on “environmental economic approaches for liquid and solid waste management in small and medium towns of developing countries” at the Graduate School of the Environment, Macquarie University, Sydney, Australia.

S. Vigneswaran is currently a Professor and Head of Environmental Engineering Group in the Faculty of Engineering, University of Technology, Sydney, Australia. He has been working on water and wastewater research since 1976. He has published over 175 technical papers and authored two books (both through CRC press, USA). Dr. Vigneswaran has established research links with the leading laboratories in France, Korea, Thailand and the USA. Also, he has been involved in number of consulting activities in this field in Australia, Indonesia, France, Korea and Thailand through various national and international agencies. Presently, he is coordinating the university key research strengths on “water and waste management in small communities”, one of the six key research centers funded by the university on competitive basis. His research in solid liquid separation processes in water and wastewater treatment namely filtration, adsorption is recognized internationally and widely referred.