SMALL SEWAGE TREATMENT WORKS AND THE WATER POLLUTION CONTROL

D. DULOVICS

Department of Hydraulic Engineering,
Technical University, H-1521 Budapest

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Abstract

In this study possibilities of small sewage water treatment and disposal in regions only partially provided with sewerages are discussed from the point of view of water pollution control. It emphasises the qualitative and quantitative effects of small sewage treatment works of the hydrologic cycles of settelements (Figs 1 and 2).

It investigates the possibilities of waste water disposal in regions not provided with sewarage and it evaluates the partial and total storage and transport of waste water

— discharge it into soil by infiltration, and
— discharge it into streams as possible solutions in Hungary.

It describes the possible solutions of individual sewage treatment and points out the effect of different methods of treatment on the quality of water.

Finally it advises on the most important tasks, which are the definition of the concept of sewerage in a more differentiated manner, the establishing of a limit value for sewerage and the determination of the operational conditions of small, individual sewage treatment satisfying the requirements for the water pollution control.

1. Introduction

Water being one of the most important conditions for life, is manyfoldedly used and thereby also polluted. The "resue" of water becomes increasingly difficult and expensive [1].

One of the conditions for "resue" is the sewage treatment of water and its discharge into nature without causing any harm in it what is ensured by canalization, since sewerage, besides the collecting of waste waters includes also the waste water treatment and disposal [2].

2. Levels of providing with sewerage and drainage

Providing with sewerage and drainage, what is an approximation of the question from the side of public utilities — has different levels, similarly to that of water supply in different part of dwellings.

The methods of collecting and leading of polluted water may be correlated with the different levels of providing with sewerage and drainage.

Provision can be realized at different levels when approximated from the side of the emitter.

In the development of supply both the public utilities (settlement) and the emitter play important roles, however, decisive must be the public utilities for the sake of the protection of the environment of the settlement [3].

2.1. *Partial provision with drainage*

This group may be classified as follows:

a) Drainage is realized by public utilities in the region, storage and transport of domestic sewage from the emitter is carried out periodically, snifted waste water is transported to either a waste water treatment plant, or to so-called "shifter" or "receiver" stations.

b) Drainage is solved in the region by pulic utilities, waste water emitters are provided with small sewage treatment works. Disposal of waste water treated in these small treatment works occurs by infiltration. The sludge formed in them is transported to the centralized waste water treatment plant and treated there.

c) Sewerage is solved by sanitary sewers disposal of rainfall is realized with infiltration into the soil.

2.2. *Partial provision with drainage by public utilities*

In the case of partial provision, drainage is solved by public utilities, but e.g. waste water is in part disposed of in the region after treatment. In this case, "grey" and "black" sewage are separated within the buildings. Grey waste water is purified in small treatment works and after that, disposed of in the region. Black waste water is either drained through a system by pressure sewerage system, or it is purified in small treatment works to a limit determined by the drainage system and is drained off either in the pressure sewerage system or in the system built for the rainwater drainage of precipitations.

The sludge produced in the small sewage treatment works transferred to the waste water treatment plant and treated there.

2.3. *Provision with sewerage and drainage by public utilities*

Following cases belong to this group:

a) Rainfalls are drained by gravitation, disposal of waste water occurs by pressure sewerage or draining systems after purification in small treatment works. Sludge produced in small treatment works is treated in plants built for this purpose.

b) The draining off of polluted water occurs from the region either by sewerage system of the public utilities *(combined system)*, or by systems *(separated system)* and the disposal of waste water is taking care of by compliance with requirements for water pollution control.

2.4. *Provision with sewerage at a high level*

The criterion for being provided with sewerage at a high level is the purification of waste water produced and that of rainwater accumulated in the region in conformity with the system of requirements.

This may include the following cases:

a) The drainage system of the region ensures the treatment of precipitation before leading it into the receiving recipient e.g. by applying a reservoir in addition the collecting, leading and treatment of waste water complying with requirements.

b) An improved combined system built out in the region leads the most polluted part of rainwater fallen in the first 10—15 min to the waste water treatment plant in order to be treated there.

c) In case of overloading the system realize transfer or subsoil irrigation from the recipients.

From the above it is seen that the multisided solutions of canalization differ from conservative leading aspects and that they are more complex and take more care of *water management*. At the same time, they ensure a more versatile investment policy as well.

From the many possibilities, always the one most economical for the given region should be preferred. However, in Hungary, there are no economical limiting values elaborated for the individual levels or solutions of sewerage [4]. Considering the earlier development an future state of drinking water by public utilities and provision by sewerage, as well as the changes in the direction of the development of settlements in Hungary, the ratio of dwellings provided with types of non-traditional sewerage described in paragraphs 2.1., 2.2 and 2.3/a is estimated for 30—35%, which means an amount of waste water originating from about 3—3.5 millions of inhabitants. The disposal of such an amount of sewage is worth caring for, therefore in what follows, the possibilities of small sevage treatment and disposal of waste water and their effects on the quality of water will be discussed.

3. Possibilities of sewage disposal in non-seweraged regions

In regions partially provided with drainage or drainage solved by public utilities it is in the interest of water pollution control that the treatment and disposal of waste water should be at about the same level as that in waste water treatment plants.

In Hungary, the following possibilities exist for waste water disposal in this case [5]:

3.1. *Partial or total storage and transportation of sewage*

This solution may be very favourable from the viewpoint of water pollution control if storage and transportation satisfy the following requirements:

- The reservoir should be water-tight not only when it is built but also under operating conditions. According to experience in the literature [6], in about 23% of reservoirs not permissible leaks were observed. No results are known in this respect from Hungarian studies, but the incorporation of porous brick, beer bottles, etc. into reservoirs is a "public secret".
- It has to be guaranteed that sewage being transported (snifted) does not get into receiving streams or some other not allowable places. It is well-known that it is very hard to check whether this requirement is complied to or not.
- For the transportation of large amounts of sewage a suitable park of vehicles should be at disposal. A truck capable of transporting 4.8 m^3 of waste water can transport a yearly amount of 5760 m^3 when calculating with 6 transports a day and 200 working days per year. If we consider a discharge of sewage of 150 l/day capita, the truck can serve out 105 inhabitants. This determines also the economic aspects of snifting.
- The treatment and disposal of the sewage transported should also be ensured. For this purpose, existing sewage treatment plants are the most suitable, if they are capable of receiving the sewage from the viewpoint of their capacity and treatment technology.

In addition to the requirements mentioned, the most important problem is the ever increasing cost of transportation. On considering these costs and the small size of parcels (where the total amount of sewage cannot be dried out), the demand for the separation of sewage inside the dwelling arises [7, 8] as it was mentioned in paragraph 2.2. It is advantageous from the point of view of transportation, because only 20—25% of the total amount of sewage has to be transported. This 20—25% contains almost 50% of the pollutants according to reference [7]. To study the possibilities of this partial transportation is also timely because the drying out of "grey" sewage which is less polluted may eventually be solved also in our smaller parcels [4].

3.2. *Infiltration of treated sewage into the soil*

In the case of disposal of waste water into soil the natural purifying ability of soil is utilized. Thus prepurification may be less careful, e.g. a septic tanks (problems concerning these solutions will be discussed later). Direct introduction into soil may be realized by either a dry wells or by under drains [9]. The parameters for calculating and planning of disposal are regulated

satisfactorily. However, few information and experience is available about the operation of such equipments.

Conditions for infiltration are that suitable soil should be available and the level of ground water should be in an appropriate depth. Besides, the procedure must not hurt the interests of water pollution control. In Hungary, disturbances in the hydrologic cycle of settlements were recently caused mainly by the lack of sewage. These problems were the rise of the level of ground water and its pollution [10].

In Figure 1, the effect of waste water disposal on the hydrologic cycle of a settlement is illustrated. The extent of pollution in the hydrologic cycle of the dwelling is significantly increased by returning the waste water into the cycle, mainly in settlements not provided with sewers or sewage treatment plants. Pollution appears also in the ground water used as receiving recipient, and it manifests itself e.g. in the increasing nitrate content of ground water which, in turn, affects the water supply [11].

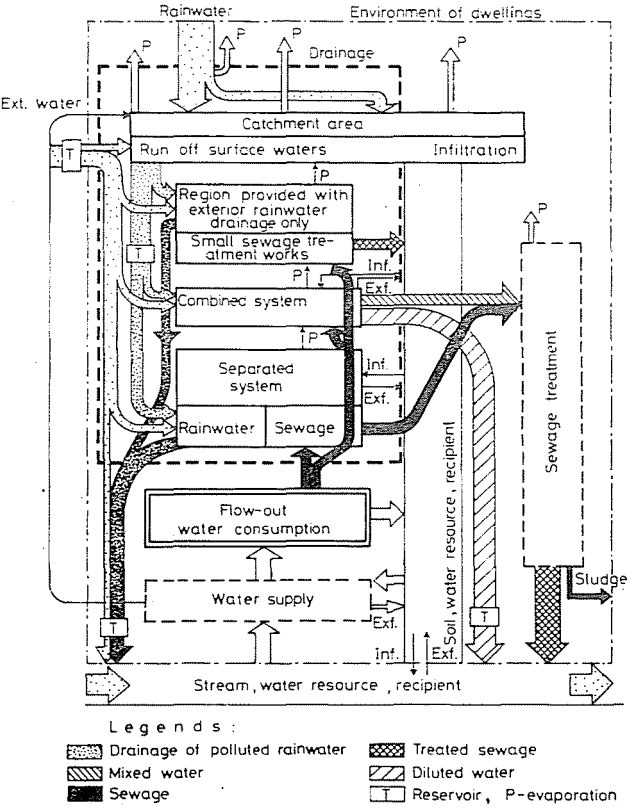

Fig. 1. Scheme of the hydraulic cycle of urban areas

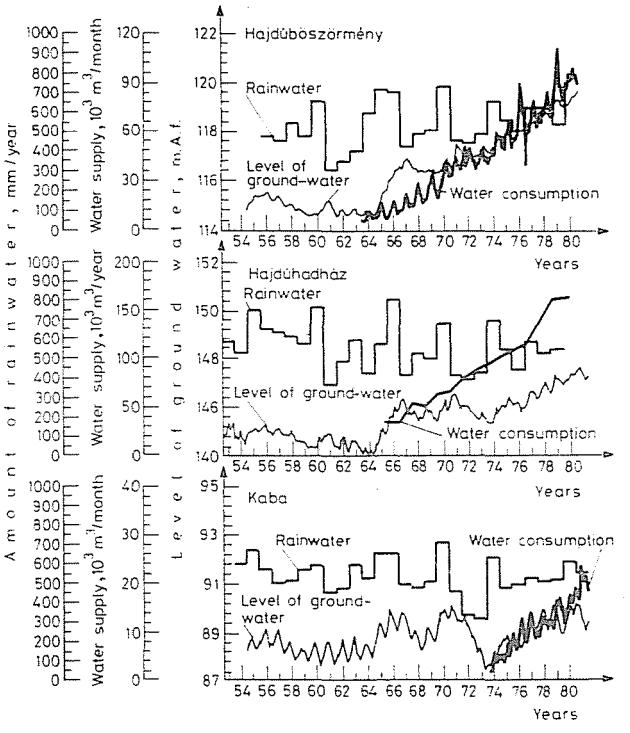

Fig. 2. Level of ground water and factors influencing

In addition to pollution, a significant danger is also the rise in the level of ground water due to the increase in both, water consumption and waste water outlet, as is shown in Fig. 2 [12].

From Figure 1 it is obvious that in the case of disposing of sewage into soil the water balance is influenced besides the introduced or infiltrated water discharge also by evaporation. This effect can be utilized, mainly in temporary settlements (holiday resorts), for decreasing the amount of sewage introduced into the soil, since evaporation by plants and soil is in summer significant. Near-surface infiltration, at the same time, is utilized in the root-zone of plants as a nutrient supply for them, thus it does not pollute the ground water any more.

3.3. *Disposal of purified sewage into streams*

In the case of introduction into streams, regulations concerning the limiting values of pollutants should be complied with (3/1984/II.7/OVH). This prescribes one of the following methods for sewage purification:

— sand filtration,

— biological purification (activated sludge or trickling filters dropping body method)
— chemical treatment (polishing in specific cases).

The methods listed in general preceded by mechanical treament processes.

4. Possible methods of small sewage treatment works

Septic tanks have serve for a long time the sewage treatment of family houses or smaller institutions in regions with a low density of inhabitants. They are characterised by a relatively small cost of investment, minimum demand on mainateinance which is mainly restricted to the disposal of the sludge and thus by low operation costs. Their main disadvantage is the relatively low efficiency of purification, therefore harmless disposal of sewage may be realized in them only by the complementation with infiltration or sand filtration.

Composite processes of purification in such tanks are: mechanical purification, separation of suspended solids in the sewage base on density differences, sedimentation and flotation storage of these materials and a subsequent biochemical decomposition of their organic material content.

From the viewpoint of the efficiency of decomposition, mechanical purification plays an important role. Purification efficiency of pools is usually 30—40% for BOD_5 60—70% for suspeded solids depending on the time of residence.

The widespread opinion that a multichamber structure levels off impulsive loads [7] is, however, disproved by experiments. Similarly, for sewage storages (see paragraph 3.1.), the water tightness of the tank is a requirement in the interest of water pollution control.

The water-tight realization of engineering structures was the aim of experiments carried out jointly by BME BVM and MFCPB [13, 14]. Considering the practice in Hungary, the effect of the storage of sludge on residence time should also be studied. According to our investigations [5, 14], the volumes given in standard plans are not in accordance with the frequency of sludge removal.

Sand filtration is based on the biological treatment effect of microorganisms settled on the upper part of the filter and on the mechanical filtration effect of sand. Its dimensioning and planning parameters are regulated, information about their operation and efficiency is scarce, similarly to infiltration equipments. The device for loading ensuring the batch operation of the filter is worth mentioning the standard design of which should be revised.

Experience concerning the operation of small treatment works with biological trickling filters varies [11, 15, 16]. In Hungary, only percolating filters were applied as small treatment plant.

Sewage treatment by activated sludge is the most widespread biological treatment process in Hungary. Unfortunately, the numerous advantages of the procedure may be transferred to small treatment works only to a restricted extent. While decomposition process is under continuous control in sewage tratment plants and thus it can be interfered in if necessary, small treatment works should operate without any expert checking for long times. In addition, small equipments are influenced more disadvantageously by the fluctuation in the limits of load, temperature of sewage and climatic factors than the large plants. There are higher requirements on the operational safety of small equipments because they are judged at the same level as sewage purification stations of the dwellings from the viewpoint of water pollution control. Following requirements are set for small equipments operating with activated sludge system [7, 16, 17]:

- it should be a simple structure which can be built easily and which provides safe purification results,
- the treatment technology should be simple and capable of coping with the large fluctuations in hydraulic and pollution load,
- simple, unostentatious operation and checking,
- exclusion of pollution and acoustic trauma,
- low investment and operational costs.

Abroad, as well as in Hungary, a number of small sewage treatment work using activated sludge are in operation. A minor part of them works with a technology ensuring high loading biological treatment process, whereas the major part operates with the so-called total oxidation technology.

Information about the operation of small sewage treatment works both in Hungary and abroad is scarce. However, considering that the study of small treatment works is not complete, in order to form a final opinion more widespread investigations are necessary.

The difficulties and disadvantages of small sewage treatment works are generally the following:

- they do not perform according their designed capacity,
- they cannot endure impulsive loads of discharge and pollutants,
- they lack expert and careful handling,
- they are not safe enough, their safe and continuous operation cannot be guaranteed,
- their service problem is not solved.

5. Summary, suggestions

In order to satisfy the increased requirements of water pollution control, the efficiency, conditions of the situation and effects on the environment of small treatment sewage works should be dealt with corresponding to its importance.

The most important tasks may be summarized as follows:

a) The concept of sewerage should be revaluated and actualized due to technical developments, unfavourable changes in the hydrologic cycle of dwellings and the halfpace in the development of dwellings. This is closely related to a more suitable, more differentiated formulation of provision and degree of supply.

b) The field of application for small sewage treatment works individual purification should be determined by the elaboration of the limiting value of economically applicable sewerage by public utilities in accordance with the requirements of water pollution control.

c) By revising present building habits, operational and checking methods, an overall picture should be get on the different types of small sewage treatment works operating in Hungary, and suggestions should be elaborated on the basis of this evaluation for the design paramers, standard design, expert operation, service and checking of these small sewage treatment works.

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Dr. Dezső DULOVICS H-1521 Budapest