LOW COST TECHNOLOGIES FOR WATER TREATMENT AND WASTEWATER COLLECTION AND TREATMENT

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1- Slow Sand Filtration for Water Treatment

In many developing countries like India and Thailand and also developed countries like USA and Holland many studies were conducted, concerning slow sand filters as a means for water treatment that has many advantages that suit the abilities of these countries either economically or technically. These studies indicate that slow sand filters are markedly affected by the climatic conditions and the raw water characteristics.

Thus it was of great importance to conduct and apply wide studies for the use of slow sand filters as an economic system for the treatment of potable water. It was important to consider both of the climatic and economic conditions of the Egyptian rural areas in order to obtain suitable operation and design criteria.

Upon what we have previously mentioned, a pilot project was initiated as a scientific cooperation between the University of Mansoura and the International Development & Research Center (IDRC), Canada. The project title was “Slow Sand Filtration for Surface Water Treatment and Cercarial Removal in Egyptian Villages”. The pilot research plant was constructed in 1990, with operation started in December 1990. The operation of the pilot plant continued to cover all the seasons of the year.

Depending on the results obtained from the pilot research work, an agreement was made between the University of Mansoura and the Science & Technology Cooperation Program, an affiliate of the Academy of Scientific Research, to construct a large scale slow sand filter water treatment plant to serve one of the Egyptian villages, and to provide its safe water requirements. This project was funded by the United States Agency for International Development (USAID) and it was constructed on a large scale to serve the whole village, Toukh El-Alklam village, in the Dakahliya Governorate. Figure (1) shows a cross-section in the main components of the treatment plant together with the water flow and the different treatment stages.

Depending on the achievement obtained from the pilot projects and from the actual implementation of slow sand filtration plant in Toukh El-Aklam village, the University of Mansoura together with the IDRC, Canada, constructed another water treatment plant at Ezz El-Deen village in the Bihera Governorate. This came as an urgent requirement for potable water within the village as the existing ground water sources provided contaminated water. Many comparative studies were conducted to evaluate the technical and economical efficiency of the slow sand filtration systems.

As a result of these studies together with the results obtained from the pilot project and the implemented projects within the two villages named above, the slow sand filtration system proved to be a very cost effective system in the treatment and production of potable water. It produces a highly safe drinking water; its operation suits both the Egyptian economic and climatic conditions. This system was, however, found to be suitable for populations of up to 50000 capita. The main advantages of is system included:

- The high quality of water produced which meets the Egyptian standards.
- It requires low technologies.
- Ease of operation and maintenance.
- It suits the Egyptian economic conditions compared with the conventional water treatment systems. The construction of the slow and filtration systems was found to be lower than the conventional compact treatment plants by about 30-40%, with its operation and maintenance costs less by about 60%.
- It also helps to conserve the environment and produces no any pollution i.e. chemicals ….etc.
- Its optimum efficiency in the removal of Bilharizial Cercaria.

2- Rehabilitation and Upgrading of the Conventional Compact Water Treatment plants

Due to the fact that most of the compact water treatment plants now existing in service specially in the Egyptian communities, were designed mostly to treat highly turbid surface waters, it therefore includes primary settling vessel. Also, in order to obtain high quality treated water from such plants, it is required to apply polymer injection to the raw water for flocculation purposes.

Many years ago, surface waters in Egypt was getting less turbid specially after the construction of the High Dam on the River Nile. This in turn resulted in uneconomic operation of the pre-mentioned compact plants, with a reduced efficiency, regarding that polymers are not locally produced, with its life time being relatively short and still relatively expensive.

Researches carried out through the Faculty of Eng., University of Mansoura, to use different techniques for water treatment, including contact flocculation, direct filtration (one or two stages), found that such simple techniques are effective and efficient for water treatment and most suitable for the conditions dominating in Egypt. However, these techniques proved and obtained a very high quality effluent.

Accordingly, some of the existing compact water treatment plants were modified in order to apply the proposed techniques in its operation. This in turn necessitated to completely changing the train of its processes. The most important advantage of these modifications was its being easily applied and its low cost requirements compared to the plant initial cost, also the obtained upgrading of plant capacity and improvements of the treated effluent characteristics.

Upgrading of the conventional compact treatment units included increase of plant capacity from $100 m^3/hr$ up to $185 m^3/hr$ or $285\ m^3/hr$. Field application and construction of the two types of upgrading (185 &

285m^3/hr) necessitated a total cost of LE 240,000 and 340,000 respectively, also operation and maintenance cost was reduced from 45 piasters to 21 piasters per each one cubic meter of the treated effluent. The modification presented here provides the following advantages;

- High efficiency of treatment, pollutants removal, and resistance of sudden loads.
- Long operation period of filters before being clogged, thus decreasing filter off-time, and wash-water requirements.
- Decrease in construction cost.
- Decrease in operation and maintenance cost, with the system being easy to operate and maintain.

3- Low Cost Compact Water Treatment Plant

Depending on the different researches and studies conducted between the University of Mansoura and the Academy of Scientific Research and Technology, design works for an integrated compact treatment system for producing a low-cost potable water treatment system were made. This system uses direct filtration on two stages to produce 100 m^3/sec and is a joint cooperation between the University of Mansoura, Academy of Scientific Research, General Organization for Potable Water & Sanitary Drainage (NOPWASD) and the Air Craft Factory with the Arab Organization for Industrialization (AOI).

The design works have been completed in collaboration with these organizations and currently a model is being constructed for implementation.

3-1 Description of the new low cost treatment plant

This new system depends mainly on direct filtration on two stages as an integrated system for water treatment. The system could be described as follows (Figure 2):

- The preparation and addition of the coagulant
- Rough / Contact Filter
- Rapid Sand Filter
- Disinfection units (addition of chlorine)
- Other service units.

3-2 The operation steps could be summarized as follows:

a- Pumping the raw water from the intake source and the addition of alum (after preparation) to the raw water by direct injection in the pipe line (in line mix).

b- Water is the discharged into the rough contact filter. This filter can work with high rates and for prolonged periods of time due to the characteristics of the raw wastewater in Egypt. This filter has two main functions:

Firstly: Trapping the relatively large materials and the removal of algae.

Secondly: This filter acts as a flocculator, with the flocs are made within the filter. The flocs are either retained within the filter or pass to the sand filters, but usually a high percentage of these flocs are reducing the turbidity. This filter is washed in that of the same manner as the rapid filters

c- Water effluent from the rough filter flows to the rapid sand filters where it undergoes final sedimentation. Experimental operation showed that these rapid filters have a high efficiency and they have prolonged periods of operation.

d- The treated water is disinfected by the addition of chlorine at the inlet of a ground storage tank, and after that the water becomes fit for human consumption.

4- Small Bore Sewers for Wastewater Collection & Treatment

The Egyptian village is faced with many problems and obstacles, and it mainly includes the method of disposing domestic wastewater due to the fact that almost all villages are supplied with potable water without the provision of a means of collection and disposal of wastewater. As the provision of safe disposal of sewage achieves health protection and promotes the standard of health within the villages. The use of septic tanks is the only on-site collection and treatment method currently used in unsewered Egyptian villages. The Egyptian government was faced with many problems during the construction of sewage collection and disposal systems and they mainly include high construction costs and the difficulties in operation.

Due to the worldwide increased experience in sanitation, many wastewater collection and treatment methods are available. But the most popular methods commonly used include:

- Conventional Gravity Networks.
- Small Bore Sewers Networks.

The conventional gravity collection sewer system has gained a wide spread popularity and preference among the Egyptian towns and cities due to the surplus available experiences in the design, construction, operation and maintenance of this system.

Due to the increased problems related with this system which include high groundwater table and narrow roads which increase the duration and costs of construction upon its implementation within the Egyptian villages; which is the current Egyptian perspective. Consequently, Prof. Dr. Ahmed Fadel initiated a research project for studying and evaluating the small bore

sewer system on the pilot level (in Nawag village) and on a large scale in the field level (the whole Nawag village and Senhour village).

In the small bore sewer system, household domestic wastes are collected in the septic tanks (interrupter tank) usually situated near the houses. Wastewater collected in the tanks is retained within the septic tanks for about 2-3 days where it undergoes sedimentation, decomposition and trapping of the special inlet and outlet configurations. Clear settled water is collected from the tank by means of PVC plastic pipes with a diameter of 2 to 4 inches. Water flows through the pipes as a result of the difference in elevation and not by gravity (slope) as with the conventional system, thus requiring no deep excavations. As the wastewater is partially treated within the septic tank contains, no solids, thus minimum or no slope sewers could be successfully implemented.

In the small bore sewer system, Figure (3), the septic tanks near the houses play a very major active role that could not be abandoned within the system, the degree of treatment and the costs of construction, maintenance and operation. The tanks have many advantages and great influence on the degree of treatment and costs of construction maintenance and operation.

Depending on the field studies, research, evaluation and the final implementation of the small bore sewer system in both Nawag and Senhour villages, it was found to be suitable and most adaptable to the Egyptian rural conditions. This system also suit the narrow street found in almost all the Egyptian villages. On comparing this system with the conventional system, it was found that this system are cost-effective with respect to the conventional systems by about (39-42) % with operation and maintenance cheaper by about (16-23) %. Evaluation and cost studies showed that the costs of the treatment plants within the small bore sewer system are

markedly reduced compared with those within the conventional systems. The reduction percentages reach (40-49) % for construction and (54-57) % for operation and maintenance.

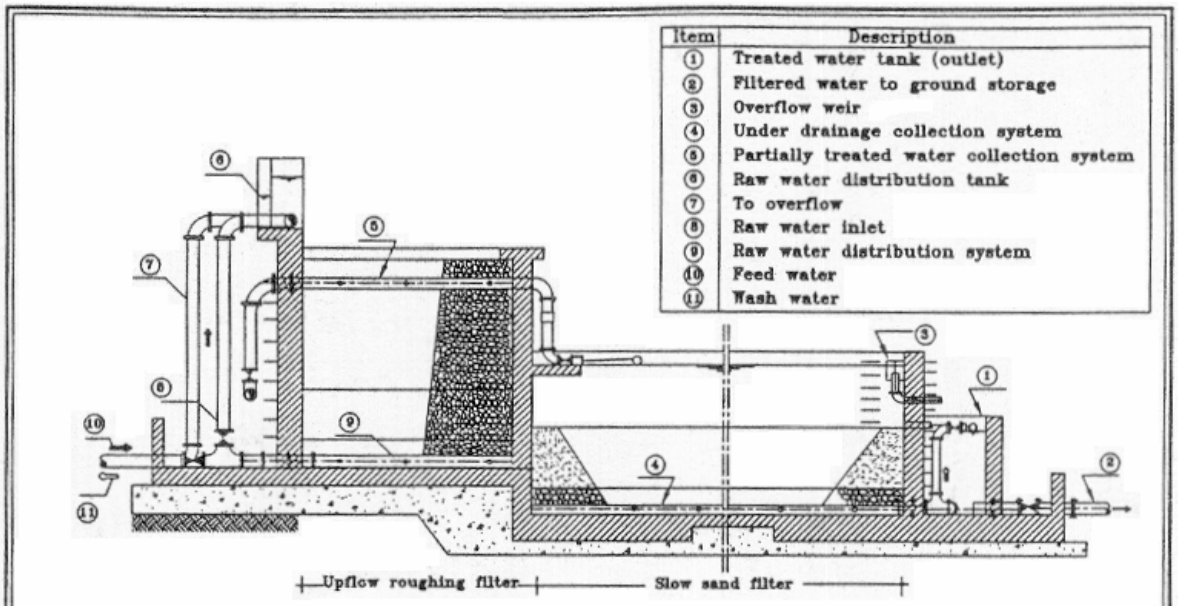

Figure (1) Illustrative cross section for the slow sand filters and upflow roughing filters in Toukh El-Aklam water treatment plant

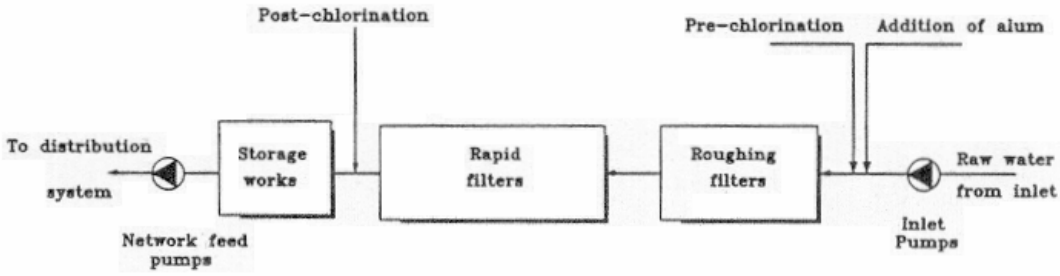

Figure (2) A general layout of a low cost compact unit treating 100 m³/sec

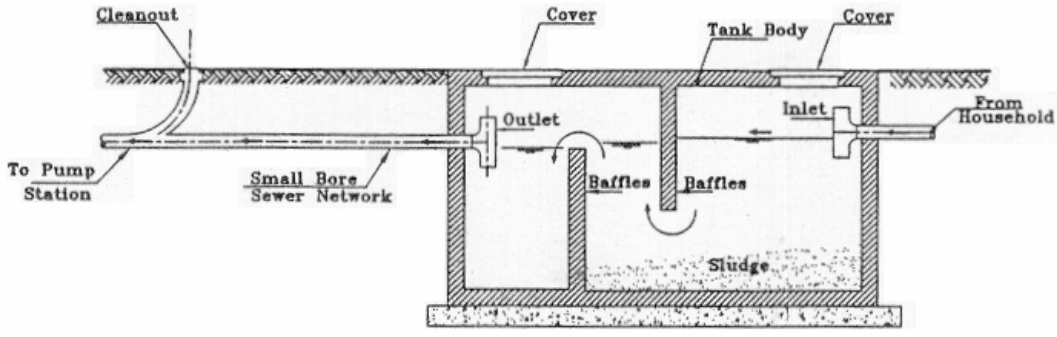

Figure (3) Model of septic tanks within the small bore sewer systems